DOCUMENTING AND UNDERSTANDING EVERYDAY ACTIVITIES THROUGH THE SELECTIVE ARCHIVING OF LIVE EXPERIENCES

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Documenting and Understanding Everyday Activities through the Selective Archiving of Live Experiences

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To my family, now and to come,

I love you dearly and thank you for all you do.

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An ancient Hebrew parable tells the story of King Solomon sending a trusted servant on an impossible quest to find a magic ring. When sad, the wearer could turn to the ring and would be happy. If happy, the ring would make the wearer sad. To everyone's surprise, the servant eventually returned with a simple ring, engraved with the phrase *Gam Ze Yaavor*, "this too shall pass." This simple phrase reminds us to look to the future during the dark times and to be joyous and thankful during good times, because they may not last. During my own quest to complete this dissertation I have had many good times and bad, and I have been strongly supported by so many people, some of them reminding me that indeed "this too shall pass." They brought many times of joy and messages of humility and perseverance. Text on a page seems inadequate to express their contribution, but here I thank some of those wonderful people in my life.

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SUMMARY

This research focuses on the development and study of socially appropriate ways to archive data about important life experiences during unexpected and unstructured situations. This work involves three significant phases: formative studies to understand the data capture needs of particular populations of users in these situations; design and development of a technical architecture for capture and access in these settings coupled with design and development of applications for two specific domain problems; and evaluation of this solution as it pertains to these domain problems. The underlying solution presented in this dissertation is known as selective archiving, in which services are always on and available for recording but require some explicit action to archive data. If no such action is taken, recorded data is deleted automatically after a specified time.

Selectively archived segments of data can provide an efficient way to recover and to analyze high quality data that traditionally available. The projects presented in this dissertation provide insight about the ways in which we can support record-keeping in informal and unstructured settings. Furthermore, when examined together, these projects provide a view into the larger generalized problem of unstructured capture and access and the acceptability of capture technologies. These considerations evolved into a set of seven tensions surrounding recording technologies that are presented in this dissertation. Furthermore, the experiences surrounding the deployment and evaluation of selective archiving technologies demonstrate the ways in which people use different types of knowledge and cues from the world to determine their reactions to and adoption of such technologies.

CHAPTER 1

INTRODUCTION

Even under the most informal of circumstances, people may want a record of what occurred. They can use these records to augment their memories, to share experiences with others who were not present, to provide fodder for discussion, or simply to provide an archive for which future uses have not been clearly defined. Thus, many researchers have explored ways in which people can capture, either automatically or manually, the details of experiences. Abowd and Mynatt define the broad problem of capture and access as capturing information so that it can be successfully accessed later (Abowd and Mynatt, 2000). Truong identifies several areas for future exploration of capture and access including capture of information in inherently unstructured or informal settings (Truong, 2005). In this dissertation, I discuss an exploration of the specific *natural environment*[1] capture and access problem, which I define as the capture of information in an unstructured, unexpected, and often informal situation so that it can be successfully accessed at a later date.

Capture of information can be extremely difficult when recording that data was not planned beforehand or when the setting is so informal and unstructured that it does

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[1] Throughout this dissertation, I use the phrase *natural environment* to mean those settings that are not prescribed or set up in a particular way. The natural environment includes the everyday situations for which we do not necessarily expect to capture and also those that do not include inherent structure, such as agenda items or prescribed educational materials. For example, in the case of teaching a child with autism, if a child recognizes a spoon in the classroom, there is the need to test whether he has generalized it to all spoons he might encounter in places like a kitchen or restaurant, the natural environment. Similarly, if a child demonstrates intense behaviors in everyday life (the natural environment), those behaviors may or may not be replicable in a controlled clinical setting.

not naturally afford recordation. Anecdotally, anyone who has jotted down a note on the proverbial cocktail napkin to remember a brilliant idea hatched during a casual discussion can attest to the need for and difficulty of data capture in those situations. Yet, later when a formal discussion around that idea may take place, the initial ideas and associated details are extremely important. As in that example, when those records can be used in formal and/or structured discussions at a later time to facilitate decision-making or other work, people often develop alternate strategies for saving the information. Some examples of these cases and their current solutions are:

- health and medically related situations, in which a diagnosis is unclear or the treatment plan needs to be monitored closely, often result in the use of patient diaries or other mobile recording tools;
- educational settings in which a child's learning style and speed may be markedly different than the average population and thus difficult to track often require extensive narrative or form-based notes for the students;
- Impromptu meetings, in which the details of the discussion might feed into a larger more formal discussion at a later time, can result in quick notes jotted down and transcribed for distribution later.

1.1 Exploring Natural Environment Capture and Access

Although people have developed strategies for managing capture and access in informal and unstructured settings, these strategies can still fail, particularly when richer media (*e.g.*, audio and video) is needed or the strategies break down (*e.g.,* the perpetually lost scrap of paper). In this dissertation, I describe two settings in which various strategies have been employed to record important information with varying success. I further describe the ways in which new capture and access technologies may further support activities in these settings.

1.1.1 Evidence-Based Care and Data-Based Decision-Making

Evidence-based care (EBC) is an increasingly popular process for long-term diagnosis and monitoring of education and healthcare disabilities. EBC combines information from state of the art research (the latest medical evidence) with personalized care based on evidence collected about an individual. Because this evidence must also be collected in everyday life, EBC is a technique that can greatly benefit from automated capture technologies. These solutions, however, can raise significant concerns about privacy, control, and surveillance. There is a trend toward evidence-based practices to guide data-based decision-making in healthcare and education. For example, when dealing with behavioral concerns (e.g., social disorders of school-aged children) or highly individualized conditions (e.g., autism), the best evidence often includes episodes from real life. Thus, there is a strong argument in favor of recording snippets of daily life and analyzing them to formulate a plan to improve the life of an individual, but that recording is both expensive to obtain manually and threatening to obtain surreptitiously.

I chose to explore in depth the important challenge of recording data supporting the care of children with autism (CWA). Individuals with autism tend to be extremely individualized in their behaviors, learning styles and abilities, and outlooks toward the world.[2] Thus, understanding, caring for, teaching, and supporting a particular individual can require in depth personalized data. Furthermore, many of the concerns about

[2] A popular saying amongst caregivers, researchers, and parents alike in the autism community is "If you've seen one child with autism, you've seen *one* child with autism" alluding to the intense differences often observed between these children, and the sometimes difficult time people have in attempting to generalize these observations.

learning for CWA, both in terms of traditional educational goals and in terms of life and social skills, center on their abilities to generalize teachings to the larger world. Thus, documentation must occur outside of structured settings, in the natural environment. Finally, schools present a setting in which the need for data is very high but so is the potential risk of creating and keeping video records. Videos can be used to diagnosis and monitor problems in classrooms, which can be beneficial to the students, but which may identify problems with school employees, a risk for them. Furthermore, children, particularly children with special needs, are usually considered a vulnerable population that should be protected from undue potential risk, such as the sharing of video records about them.

1.1.2 Informal Capture in a Casual, Shared Space

I continue to be interested in the larger, more general informal and unstructured capture problem and continue this work with an eye towards the possibility of generalization. In addition to discussions of capture in the natural environment for children with special needs, this dissertation also focuses on uses and perceptions of capture technologies in a casual, shared space. In this way, I am able to address the larger considerations of natural environment capture for a variety of experiences.

A casual, shared space provides an interesting contrast class to the exploration of natural environment capture in a school setting, because both the risk inherent to and the need for audio and video recording are potentially lower. Because casual spaces are by nature informal, many of the activities that take place in them are also casual and require little additional recording. Most people can recall a moment when they wished they had documented something in such a space (*e.g.*, that brilliant research idea that could never be formulated quite the same way again), but those experiences are fewer and farther between than the severe behaviors that can be present in a special education classroom. At the same time, in a shared, public space people are unlikely to do things that they may be fired or sued for doing (a typical and high risk concern for people when considering video recording in schools).

1.1.3 Bringing these domains together

By gaining a deep understanding of capture and access in the specific domain of recording behavioral data about CWA, I have been able to develop a generalized approach to data capture in the natural environment. In-depth explorations of the application of this approach to different domain problems also informs the ways in which perceptions, adoption, and use may be affected by both the affordances of these technologies and the context of the interactions they are meant to support. In addition to the work surrounding capture of behavioral information in special education classrooms, exploration of both mobile personal natural environment capture applications and a location-specific, but generalized natural environment capture system adds to the considerations of the general natural environment capture and access problem. The perceptions, uses, and adoption patterns of a similar design and architectural system can both be similar and vary dramatically across multiple domains and contexts. Furthermore, certain applications and solutions may be appropriate for particular situations and not for others. By further mapping out the design space of capture and access for the natural environment, this work may motivate researchers to explore unstructured and informal capture settings further in different domains as well as to provide guidelines for design that may assist them in these explorations.

This dissertation includes a description of the issues surrounding natural environment capture and access, both specifically for children with severe behavior disorders and other special needs and as a general problem. These concerns were uncovered as part of a set of formative studies and are distilled into a set of design guidelines. I also include a description of the Experience Buffers architecture built to record, to automatically delete, and to allow for manual archiving of audio and video data to support these settings. This dissertation also incorporates two systems built to take advantage of the Experience Buffers architecture and investigations of the ways in which they address particular human needs and provide for new ways to examine those domains:

- CareLog, a system that was built to assist caregivers of CWA in documenting and analyzing specific unplanned incidents of interest as part of a specific diagnostic technique, functional behavior assessment (FBA); and
- BufferWare, a system that was built to allow for the capture of impromptu meetings and conversations in a casual, shared space.

I describe how these systems addressed the challenges inherent to capture in the natural environment. Furthermore, using these systems, I explored these challenges in depth, uncovering other challenges and opportunities, and revealing some characteristics of those situations and domain problems in which buffering is a solution to capture and some characteristics of those in which other solutions may be more appropriate.

1.2 Purpose of Research and Thesis Statement

Many people have already shown why record-keeping is important for preserving a memory of a particular event and how it can distract from paying attention to the incident at hand (Bush, 1945; Brotherton, 2001; Truong, 2005; Weiser, 1991). Furthermore, I assert that an always-on fully automated capture solution is not appropriate for a variety of social and technical reasons in everyday, natural, and unexpected situations and discuss this point in detail in this dissertation. In this dissertation, I demonstrate how selective archiving of automatically captured media can enhance record keeping and documentation of everyday activities at times in these natural settings. Selective archiving uses a collection of capture services embedded in an environment. These services are always on and available but require explicit user action to store an experience. Capture services in the environment record, automatically delete, and allow for manual archiving of audio and video data.

I now present my thesis statement:

> *Selective archiving provides an effective way to record rich data in unstructured, natural settings, providing users with a more efficient way to record and to analyze higher quality data than available traditionally and addressing some of the social and technical concerns perceived about continuous capture applications.*

For this dissertation and as part of a larger research team, I conducted multiple formative studies of capture in the natural environment, including a long-term ethnographic study of caregivers of CWA. I then designed the Experience Buffers architecture to support these competing needs, confirmed its appropriateness through a series of focus groups of caregivers of CWA, and implemented that architecture and two applications that utilize its services. These two applications are CareLog for documentation of behavioral incidents of CWA and BufferWare for capture of impromptu meetings and conversations in a semi-public space. I conducted a study of authentic use of CareLog in real classrooms at a local county run center for behavioral education. I also conducted a study of adoption, use, and perceptions of BufferWare in an everyday, shared, casual setting for over a year. This process of exploration, design, implementation, and further assessment together provided a test bed upon which I could examine the hypotheses of this dissertation.

Specifically, to evaluate my thesis statement, the following tasks were completed.

- a series of focus groups to identify if a buffered approach does in fact address the concerns of no capture and of continual automated capture for children with special needs and that this approach is in fact perceived to be more adoptable than the other two approaches;
- a controlled study in schools during which I measured the efficiency and workload of the FBA process, the quality of analysis by caregivers, and their perceptions and experiences while using both technology augmented and traditional (pen and paper) methods for FBA;
- a study of the perceptions, adoption, and use of BufferWare and the Experience Buffers in a casual, shared space during which I gathered information about new uses for these services and further probed whether and in what ways the Experience Buffers address (or don't) concerns inherent to solutions at both ends of the capture spectrum: no capture or fully manual capture all the way to continual fully automated capture.

1.3 Results and Contributions

The overall objective of this dissertation work is to understand how capture and access in the natural environment can support unstructured and unexpected activities. I primarily consider the focused domain of documenting and diagnosis behavioral incidents for CWA and then use that knowledge to inform other domains on how to build capture and access applications. I furthermore use the more generalized domain of interactions in a semi-public space to understand how people might use the experience buffers outside of the domain for which the architecture was originally designed.

Some of the expected contributions were:

- design and development of a semi-automated architecture for capture and access that provides manual controls and balances many of the social and technical considerations that have impeded fully automated capture to be used throughout a broader domain of applications and environments, Experience Buffers;
- design and development of two applications that take advantage of the Experience Buffers architecture for very different domains, CareLog and BufferWare; and
- an understanding of the larger social and technical issues involved in attempting to capture unplanned and unstructured but significant events in everyday life through experiences with manual, automatic and buffered capture systems.

As is prone to occur in research, some unexpected contributions have also emerged from this work:

- observations about the ways in which teachers can proactively adopt practices encouraged in the educational literature and by professionals and specialists who informed our initial designs, such as using video as self-reflective practice to improve classroom activity;

- observations about the effects of various notification mechanisms on perceptions about natural environment capture and about research projects focused on capture more generally; and
- a more nuanced understanding of the ways risk of capture and its benefits can affect adoption practices and perceptions across both high and low need of capture situations.

1.4 Overview of Dissertation

This thesis is divided into seven chapters:

Chapter Two describes the related work in the area of natural environment capture and access. I first outline the historical background of recording, capture, and education, including both the historical value of recording and a brief overview of relevant work from education, psychology, anthropology, and sociology. This section prepares the reader not only for understanding the ways in which capture and access as a class of applications fits into the larger scientific ether but also for some of the specific results related to these applications' effects on the special education environment and staff. I then describe the early visions of capture and access, dimensions of the design space, and particular research and commercial technologies for informal and unstructured capture and access and for behavior and educational record keeping.

Chapter Three describes the formative studies I conducted with other researchers as part of my initial explorations of the natural environment capture problem. This chapter serves as a stepping point from which to understand the lessons and design guidelines that directly fed into the design and creation of the concept of selective archiving and of the implementation of the Experience Buffers architecture. Thus, I outline a set of requirements for capture and access in informal and unstructured settings.

Chapter Four focuses on the design and implementation both of the Experience Buffers architecture and of the applications built on it. This chapter prepares the reader for understanding the ways these technologies were developed to be tools for evaluation of the concepts uncovered in the formative stages of this work. Furthermore, this chapter prepares the reader for understanding the underlying infrastructure for both exemplar applications.

Chapter Five describes the method and results of a quasi-controlled study conducted in a special education school. I discuss the ways in which CareLog reduced the mistakes made by teachers and reduced the workload perceived by teachers. I also describe the ways in which the teachers perceived the technology, including a description of the privacy and security implications of video capture in the schools, as they both confirm and differ from the results obtained during the formative stages of this work.

Chapter Six details the methods and results of an exploratory study conducted in a shared, casual space at Georgia Tech. The results presented in this chapter stand alone as interesting observations about the perception, use, and adoption of capture technologies and specifically of selective archiving technologies in such a space. They also, however, provide a contrast class for exploration of generalized issues when compare with the in school study and application described in the preceding chapter.

Chapter Seven provides reflections on and conclusions about selective archiving, both as a technology and as a socially situated and constructed concept. The perceptions, uses, and adoption of these concepts and technologies in differing settings provides an opportunity to reflect critically on the many assumptions made about the value of not only the underlying services but also the gestalt surrounding them.

Finally, Chapter Eight provides high level conclusions, focusing on the ways in which increased availability of recording technologies coupled with the general understanding and cultural nuances present in this design space impact adoption and perceptions of recording technologies. This chapter synthesizes challenges and opportunities of recording technologies in the future.

CHAPTER 2

BACKGROUND AND RELATED WORK

In this chapter, I first describe some of the historical and theoretical foundations surrounding the concept of capturing and recording information from life experiences. I describe some of the relevant work from sociology, anthropology and education and attempt to position my own theoretical stance alongside some of these frameworks. Understanding this level of background is essential for understanding the domains studied as part of this dissertation as well as technology's place within them. As noted in the Introduction, this dissertation covers the broad topic of natural environment capture and more specifically of the use of selective archiving as a method for accomplishing this goal. This dissertation also covers in depth record-keeping and noting in the domain of special education, particularly as it relates to behavior assessment and management. Thus, an understanding of education and record keeping and technology's placement within education is also important, and an overview is provided in this chapter.

I then present background information on capture and access, on documenting relevant to medical and educational care, and on functional behavior analysis and technologies specific to the care of children with autism. I provide a brief overview of the early research visions for automated capture and access that have motivated subsequent explorations and the projects and domains that researchers have developed and studied thus far. I distinguish the dimensions of the application space upon which I differentiate natural environment capture and access from more traditional models of capture and access in the ubiquitous computing literature. I present the past research in HCI and ubiquitous computing, focusing on domain problems that indicate a different solution may be necessary for adoption of automated capture in unstructured natural settings. Finally, I review the state of the art for documenting medical and educational progress.

2.1 Historical Background on Recording, Capture, and Education

Both the human impetus to record and formal and informal education systems have been important topics of study in both the academic social sciences and more typically professional areas of study, such as computer science and education itself. Due to the enormous depth of this work across these disciplines, I do not try to document the entire history of these fields of study here. Some significant foundations, however, should be described such that readers may orient themselves to the particular foundations with which much of this dissertation must be interpreted. Thus, in this section, I begin with a review of the historical significance of recording and some foundations in psychology, anthropology, sociology, and education. I describe the ways in which particular schools of thought are influential upon this work and the ways in which they often coincide with or differ dramatically from each other. I then describe some of the work in using qualitative methods in education, similar to the approach I have taken in studying special education. Finally, I close with an overview of Functional Behavior Assessment (FBA), a concept that will be key to understanding portions of this work.

2.1.1 The Historical Value of Recording

There is no doubt that recording, whether it is histories, rules, or data, has been a significant force in human history. From the early cave paintings and hieroglyphics, to the first Bibles printed for the masses using the Guttenberg press, to the Internet and "publishing" power by the masses, the ability to record and then share information has changed the way people are able to interact, to empower themselves, and to spread knowledge. Certainly, with the advances of various recording media, sacrifices and losses have also impacted human history. Practices surrounding oral histories have been lost or reduced in many cultures. Accountability and documentation has sometimes replaced human rational thought in bureaucratic organizations. Peer-review and other quality controls have been lost in some arenas to the power of inexpensive, easy publication. In this section, I describe a few examples of the power of recording and its placement as a core human need for which technology can be an important tool, support, and effecter of change.

Angela Fernandez provides a remarkable account of the way one lawyer in colonial America remained a welcomed member of an extremely conservative community, despite his unorthodox views of religion and morality (Fernandez 2005). Thomas Lichford, although an attorney in the community for which his skills were certainly valued, may have been allowed to stay primarily due to his role as the town's scribe. This single example demonstrates what many people know to be true intuitively: those who can share information, be it through written records or other means, have access to immense power and influence upon the society for which they are recording.

The power of records may also be discerned from the immense emphasis placed on them by certain professional fields (see for example, Yakel 2001 – Radiology; Scaife and Pomerantz 1999 - Psychology; Eichhorn 1993 - Anesthesia). Notes can serve as memory aids, decision-making tools, historical documents, backdrops for collaborative discussion and more. Furthermore, "record-keeping practices are a central means by which organizations demonstrate accountability." (Yakel, 2001) Thus, note-keeping can often be a "requirement of professional practice." (Scaife and Pomerantz, 1999) Many of these practices appear to be governed by rules, regulations, and "best practices." However, many of these routines, procedures, and customs surrounding note-taking are in fact culturally and socially constructed. The context of the interaction has as much influence on the note-taking and record-keeping practices of the individuals as the content of these records, a point to which I will return periodically while describing the evaluations of selective archiving in disparate contexts.

Record-keeping, particularly video, holds a significant historical place in the methods of the social sciences. For example, George and Louise Spindler use films of research participants as "evocative stimuli" to encourage teacher reflection on classroom behavior, primarily their own (Spindler and Spindler 2000, p. 19). Charles Goodwin described the ways in which videos can be used to develop a greater understanding of interactions by cataloging those interactions using similar methods to the cataloging of speech utterances by conversational analysts (Goodwin 1996). He also describes the ways perceptions about those activities can be molded by the coding scheme used to catalogue and analyze them (Goodwin, 1994). One goal of using video and audio records in some cases, and certainly in mine, is to prevent some of the departure from reality that can be inherent to documentation manually recorded at the time of an incident or later. Even trained observers can make errors in judgment due to their own ingrained perceptions at the time of recording (Spindler and Spindler 2000, p. 219-221). Video affords the possibility to return to those experiences at a later date for further analysis. Many education researchers have also examined the ways in which video can be used in teacher preparation and critique (see for example, Lampert, 1994 and Marx *et al.*, 1998).

Use of video as records has also been noted to have its downsides. Certainly, “the camera is selective” (Spindler and Spindler 2000, p. 221). In fact, so selective that Goodwin also described the ways coding techniques can be used to recreate “truth” from video within “socially situated, historically constituted” bodies of practice. Thus, the old adage “seeing is believing” holds true. However, those who “see” using this constructed view of the video record, may see only what the constructor intends. Thus, the danger of acquiring a particular outlook regarding a setting either before or during the observation period can still be in place even when doing analysis of video records after direct observation. For example, Ochs described the ways in which the process and style of transcription can influence the outcome of analysis (Ochs 1979). Significantly, she found this influence to be present whether the person doing the analysis was present for the initial observations or not.

Despite the many flaws of recording technologies and processes, keeping records is a significant part of the production of scientific and practical knowledge. By enhancing the ways in which people can document information, we can work towards reducing some of these issues. For example, we can reduce the selectivity of the camera by providing multiple fixed views of particular interactions. We can reduce the selectivity of coding of media by keeping the media and allowing access to varied coding schemes.

2.1.2 Social Science Research in Education

Given the scope of this dissertation and its primary placement within the academic disciplines of Human-Computer Interaction (HCI) and Computer Science, a full review of sociology, anthropology, and psychology as they relate to education would be out of place. However, I do here review a small sliver of these works for two primary reasons:

(1) Some of the theoretical foundations provide significant backdrops for the discussion of the use of capture technologies in a school for educational purposes, including behavior management.

(2) Similar to researchers within the professional field of education, I, like others in HCI, have borrowed heavily from the methods and frameworks of the social sciences. Thus, a discussion, albeit narrow, of this history contributes to an understanding of my research perspective.

Researchers in sociology, anthropology, and psychology often treat education as another domain problem to which they may apply their particular analytic lenses. In fact, the larger domain problem of "education" is actually an innumerable multitude of problems worthy of study for researchers in these fields. The way in which they apply their analytic lenses, can be described roughly as:

- Educational Psychology: Psychology has perhaps the oldest influence of the social sciences on education, having been a part of formal educational programs at teacher's colleges since the early part of the 20th century. Furthermore, the tests and measurement instruments, such as IQ, were developed by psychologists. Finally, many of the early models of development and learning come from such educational theorists as Jean Piaget and John Dewey, who were also renowned psychologists. Piaget argued that the growth of knowledge is a progressive construction of logically embedded structures superseding one another by a process of inclusion of lower, less powerful logical means into higher and more powerful ones up to adulthood.

Therefore, children's logic and modes of thinking are initially entirely different from those of adults (Piaget 1970). Along with being the founder of the progressive movement in education (Westbrook 1991), Dewey was also one of the founders of functional psychology along with William James.

- Anthropology of Education: The process of learning can be viewed as similar to that of enculturation, wherein the individual and his or her experiences and constructions of these experiences is often the significant unit of study. Edgar L. Hewett, with his articles "Anthropology and Education" (Hewett 1904) and "Ethnic Factors in Education" (Hewett 1905) in the *American Anthropologist*, broke ranks with the anthropologists of the time who were primarily concerned with "ethnographic and cultural history salvage" (Spindler and Spindler 2000, p. 64). He called for teachers and educational systems to be structured such that greater focus was provided for the ethnological differences among student groups as they learn to be a part of this one greater organization of America. Maria Montessori, the namesake of the Montessori schools, considered by many to be one of the most influential of the early education anthropologists, stressed the differential meaning of school experiences for children from different social and ethnic classes (Kramer 1978). Outside of the formal educational systems that we typically consider in the United States, many educational anthropologists also consider the studies of learning in cultures without formal, government-run educational institutions to be a part of the discipline of the anthropology of education (see, for example Van Gennep 1960 and Spindler 1970).
- Educational Sociology: Educational institutions can be considered representative of and/or significant to the societies in which they reside. These institutions can also be

considered social systems within themselves, worth of study as their own units of analysis. Sociologists have explored both levels of analysis. Although modern sociological theory of education does tend to attend more acutely to larger institutions, such as are common in Europe, the United States, and other industrialized nations, some educational sociologists, like their anthropological counterparts, have also studied the indoctrination and learning processes of varied societies, such as Akinnaso's comparative analysis of learning in literate and non-literate societies (Akinnaso 1992).

- Qualitative Research in Education: Pole and Morrison define ethnography of education as an "…approach to social research based on the first-hand experience of social action within a discrete location, in which the objective is to collect data which will convey the subjective reality of the lived experience of those who inhabit the location." Case study research, as qualitative research in education is sometimes named, can often be "conducted so that specific issues and problems of practice can be identified and explained" (Meriam 1998, p. 34). Thus, in some senses, the orientation that education researchers take towards social science research and methods is more similar to the stance I take in this dissertation than the orientation that social scientists take towards education. That is, I focused on the specific issues and problems inherent to *natural environment capture and access* within education so that they could be identified and explained. I then developed the notions of selective archiving to address these issues. Again, I utilized both the methods and the theoretical frameworks of the other social sciences to evaluate the effectiveness of this solution.

Despite their differing theoretical lenses, as outlined above, in my review of the social science literature on education, many complementary themes exist within these works. Thus, the remainder of this section covers some of these themes grouped together, irrespective of the disciplines from which they originate. These themes are significant to my analysis of the uses of records and of technologies for creating and using records presented in Chapter 3's discussion of my formative research in this domain as well as in Chapter 5's discussion of the use of CareLog and selective archiving in a school.

2.1.2.1 Education as a path to "good citizens"

When taken in a broad sense, the concept of education can be considered as a slightly more formalized version of "bringing up" into society while providing fundamental instructions regarding life in society. Thus, some sociologists have described education as a political system, intended as a pathway to the construction of good citizens (Bendix 1964; Tyack 1966; Meyer *et al.* 1979). Children learn constantly, and formal education may simply be a manner of attempting to adjust what it is children would learn naturally into what the adults of the culture wish those children to learn. Thus, educational systems can be seen both as descriptions of what is currently important in society, including social roles, and descriptions of what society wishes for the future (Meyer 1977; Kamens 1988).

Given a perspective of creating good citizens who function well in society, it is easy to imagine the ways in which behavior management can become a top priority amongst educators. To the degree that education is not only a political system but also an economic force, it can be seen as preparing good citizens who are also good workers. Thus, a primary goal in some special education systems, is to reduce behavior while building "job skills." A special lab for development of such skills was used regularly at the school that served as the site of one of the major studies of this dissertation. Other social systems are also in place to scaffold the learning of these types of skills by children with special needs, such as job coaches. These coaches not only teach the particular skills required by a job (*e.g.* how to use a cash register) but also work with children and adults to help them understand the *behaviors* that are considered appropriate in different social settings by society as a whole and the workplace in particular.

For those children with severe cognitive and/or physical deficits, a future goal of traditional work may be unrealistic. However, these children will still function in society within their roles. They may interact with other people outside of the home (for example, in the grocery store or on public transportation). They will certainly interact with individuals within their homes and at school. Thus, again, behavior management and adaptation to the rules that society has developed have emerged as goals within the education system.

2.1.2.2 Measurement and accountability

In line with a discussion about educational systems as creators of good citizens who function well in society is a note about the ways in which progress in these areas can be measured. In the 1980's and 1990's in most of the industrialized world a trend towards concepts of 'outcomes' and 'performance indicators' began to appear in education. Such movements have generally fallen under the categories of outcomes-based education (OBE) and standards based education (McNeir 1993). Nearly two decades later, a debate rages on within the education and sociology of education communities regarding the (de)merits of these metrics (see, for example, Glatthorn 1993, McKernan 1993, and

Schafly 1993 in education and public policy and Smyth and Dow 1998 and Hargreaves and Moore 2000 in sociology). I summarize briefly in this section the primary issues and arguments inherent to this debate.

Outcomes-based education is one suggestion for educational reform designed to shift focus from the *inputs*, such as curriculum development, to the *outputs*, and work backwards from there to define the schooling experience. The definition of the outputs varies widely from school to school, system to system, and child to child. They can be described as anything from what the child learns to how the child tests to what the child does. Of course, some outcomes are vastly easier to measure in standardized ways than others, prompting some of the debate around these systems.

In special education, OBE has translated for the most part into the notion of Individual Education Plans (IEP). These plans are negotiated for each individual child on a regular schedule (typically once a year, but sometimes more frequently) and can include educational, behavioral, and independent living goals. Thus, the IEP can serve both as an individualized yearly curriculum plan and a yardstick by which to measure progress. Much like other outcomes based curricula, the teacher still holds at least nominal autonomy when it comes to the *how* of the implementation of these plans. Also like other OBE efforts, the exact levels of success of these plans, of teacher autonomy, of parental satisfaction, *etc.* can vary and are subject to the same critiques. The individualized nature of these plans coupled with a focus on measuring success necessitates intense documentation on the part of school staff including sample work products, behavioral reports, and sometimes video of both educational and behavioral progress. Finally, goals for special education students that require workplace or independent living skills can also require schools to accommodate new types of learning environments. For example, in some schools in Georgia, special “laboratories” have been constructed to simulate the home environment, the workplace (including machinery such as cash registers and parts to be assembled), and other external environments (*e.g.*, the grocery store). Goals for performance in these environments are set out and measured in much the same way as goals in the traditional special education classroom.

2.1.2.3 Teaching as a means for cultural transmission

The LinguaLinks Library defines cultural transmission as “the process of passing on culturally relevant knowledge, skills, attitudes, and values from person to person or from culture to culture” (LinguaLinks Library 1999). Thus, teaching can readily be considered a dominant method for cultural transmission. Special education, and particularly the education of children with severe behavior disorders, is no different. At the H.A.V.E.N. Academy, at which much one of the major experiments of this dissertation was conducted (see Chapter 5), teachers and staff use a variety of methods for teaching students “how to think, act, and feel” (Spindler and Spindler 2000, p.142) as part of this cultural transmission. Displaying “appropriate behavior” is an important goal, because appropriate behavior by all citizens is essential to the maintenance of the various cultural systems, both within and outside the school. In this section, I outline some of the types of cultural transmission witnessed and discusses throughout both the formative studies of special education in home and in school and the final in-school experiment as they relate to the literature on cultural transmission in education.

What is known as a Behavior Intervention Plan or BIP is often implemented in a school or in a home to help manage severe behavior. This plan details concrete responses to particular events. For example, a plan may include positive reinforcement items, such as giving a child the "thumbs up" every five minutes he is "on task." It may also include responses to negative or inappropriate behaviors, such as restraining a child who is hitting himself or others. Some standard plans exist, such as the Psychoeducational Treatment Model (Criste *et al.* 2003), the SAM Model (unpublished work by Criste and Neal-White) and the Boy's Town Approach (Dowd *et al.* 1993; Baker *et al.* 1996) but many are individually developed for a particular child. These plans are essentially "culturally patterned lessons" in which the culture is particular to the school, home, country, *etc.* (Spindler and Spindler 2000, p. 144).

One important part of the process of cultural transmission through teaching is the "management of discontinuity" (Spindler and Spindler 2000, p. 174), where "discontinuity occurs at any point in the life cycle when there in an abrupt transition from one mode of being to another." Traditionally, educational anthropologists have focused on significant periods of transition that are also often accompanied by significant physical changes, such as at adolescence. In the case of children with severe behavior disorders, however, even points of discontinuity that may seem minimal on the surface, can be devastating. Thus, the introduction of a new behavior plan represents a period of discontinuity for these students. As a result, behavior may even spike temporarily. For example, a common BIP for a student who hits himself to get attention would be to ignore that student's hitting, unless of course, it became so severe that his safety was in danger. Initially, the student may hit himself more, ostensibly working under the assumption that more hitting will eventually get him the attention he desires and he has received in the past. The goal of such plans, however, is to manage this period of discontinuity by following the precise directions until the behavior eventually subsides, as the student learns the new cultural norms of the classroom.

For children with autism, cultural transmission generally and periods of discontinuity specifically can be particularly difficult to manage. In describing the interactions of a family affected by Asperger's Syndrome, Sacks reports the family members "know the rules and conventions of 'normal'" but are unable to internalize these, to understand them at the level that those without such disabilities interpret the culture around them. Instead they learned "to ape human behavior" without fully understanding what's behind the customs (Sacks, 1995, p. 263).

Hendriks's discussion of Collin's Theory of Action (Collins 1990) as applied to an empirical study of a ward for children with autism (Hendriks 1998) illuminates many of these issues. Collins defines *polimorphic* and *mimeomorphic* actions to describe how it is that machines and humans continue to interact despite differences in their abilities to process certain types of stimuli and rules. Polimorphic actions are those that can be accomplished successfully in a wide variety of ways (poly, meaning many) and understood only within the context of society (poli, from the Latin root for people). He argues that people are only able to adjust to these minimal and changing rules, because they are raised by other people within a society and culture that are able to correct and provide feedback to those children regularly. Machines, on the other hand, must make use of more strict rules having not been raised by humans in the same ways. By his argument, man-machine interaction is only made possible by humans using only mimeographic actions, that is those that can be cleanly described and replicated in "space-time coordinates" (Collins, de Vries, and Bijker 1997, p.269).

Hendriks notes that "there is a risk of being uncaring, even *hurting* autistic people, *precisely by treating them as fellow human beings*." (Hendriks 1998, emphasis in the original text). According to Hendriks's discussion of autism set against this theory of action, then, one way to communicate with children with autism is via a reductionist stance that changes many polymorphic actions into mimeomorphic descriptions that are communicated more easily to these children[3]. Thus, behavior intervention plans as tools for cultural transmission may be so concrete, definitive, and unchanging in part because they aim to avoid a naïve humanistic stance that would be confusing and unclear for these children. On the other hand, however, as Hendriks also notes, "by settings its goals too narrowly, the approach carries a risk of reducing interactions … to mere behavioral problem solving" (Hendriks, 1998). Thus, it is not surprising that behaviorists, teachers, and parents alike throughout my interactions with them often described behavior management as only the first step to broader educational goals.

2.1.2.4 Maintenance of Societal Structure

Education can also often be a means of maintaining societal structure. In some cultures, successful completion of the education and indoctrination process is assured for all members of society (Spindler and Spindler 2000, p. 182-188). The system provides a myriad of continuities, regardless of the challenges and stressors encountered by the pupils of the societal and cultural systems. Thus, at the end of the process, all members identify with the shared goals of the community and are committed to maintenance of

[3] It should be noted that Hendriks (and I) in no way meant to imply that children with autism are machine-like in the larger sense, only that this theory serves as an interesting backdrop for analysis of communication interactions between neurotypical and autistic individuals.

these goals and the larger societal structure. Often, in Western and particularly American cultures, this attitude of assured success and conditions of continuity in the face of strife are not encountered by minorities (Jacob and Jordan 1987), including the minority of students placed in special education. Although people may not typically think of special education students as minorities, there are some important points to consider with regard to that distinction. First, according the Office of Human Research Protections, these students may be considered "educationally disadvantaged" and thus in need of extra protection. Furthermore, according to the Individuals with Disabilities Education Act, as of 1997 in the United States, "more [racial] minority children continue to be served in special education than would be expected from the percentage of minority students in the general school population" and "poor African-American children are 2.3 times more likely to be identified by their teacher as having mental retardation than their white counterpart" (IDEA, 1997).

In Benedict's early work regarding cultural discontinuities (Benedict, 1938), she describes the ways in which distinct discontinuities for minorities and other fringe members of cultures exist that prevent them from being successful within many educational settings. Particularly for those individuals with autism who are higher functioning (*i.e.,* they can often "blend" into regular society), the criticisms of behavior and their way of viewing the world can be confusing, frustrating, and resultant in assured failures[4]. Sinclair describes many of these discontinuities from the perspective of a high-functioning man with autism (Sinclair 1992).

[4] The children with whom this work is most directly concerned are almost all considered "low functioning," all with abilities tested at a level below 5th grade. Furthermore, these "inappropriate" behaviors are all severe, and many involve injury to self or others, as is described in more detail in Chapter 5 and Appendix G. Despite these differences between

Another aspect of many school environments that leads to these types of discontinuities is the rise in the practice of busing students from long distances and the distance, both geographically and culturally, between students' home lives and teachers. For example, at the H.A.V.E.N. Academy, the school's specialization in severe behavior necessitates that students from all over the very large county attend. Teachers very rarely visit the homes of their students, in part due to the distance, and in part due to the legal and societal norms in place to keep these environments distinct from one another. Furthermore, all of the teachers hold at least an undergraduate degree and many have also obtained Master's levels and other certifications. Meanwhile, the students in the school primarily hale from much lower socio-economic status and education levels, with nearly 80% of the students in the school participating in the free and reduced lunch programs. Women make up the majority of professionals in education. Meanwhile, male students are more likely to have autism and/or severe behavior concerns. Finally, the majority of students in the school are non-Caucasian (many are foreign born or African-American), while the majority of teachers are Caucasian and American. I do not analyze these issues in detail in this document but do point out these potential discontinuities as factors that are likely to influence these results.

2.1.3 Background of Functional Behavioral Assessment

Behavioral intervention plans (BIPs) based on an understanding of "why" a particular child behaves inappropriately can be extremely useful in addressing a wide range of problem behaviors, particularly for CWA who are included in regular education

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the experimental group addressed in this work and the high functioning population, I believe it is important to discuss the experiences of these groups, even if only in minimal detail.

classrooms. FBA is usually used as a problem-solving technique for addressing severe student problem behavior. It relies on a variety of techniques and strategies to identify the purposes of specific behavior and to help educators, parents, and other advocates develop interventions to address directly the problem behavior. The focus when conducting a FBA is on identifying significant, child-specific social, affective, cognitive, and/or environmental factors associated with the occurrence or lack of specific behaviors. This broader perspective offers a better understanding of the function or purpose behind student behavior, enabling programming teams[5] to make better judgments about specific interventions. These techniques have been shown to be effective both in clinical settings and in classroom or more natural settings (Sasso, *et al.* 1992; Carr, *et al,* 1997; Umbreit 1995; pacer.org 2005).

In conducting a FBA, programming teams first identify and define the problem behavior, then review indirect observation information from various sources (e.g., questionnaires; semi-structured interviews with students, teachers, and others). They then conduct a direct observation period in which information is recorded about the student's behavior and analyzed in various forms (e.g., scatterplots or ABC charts[6]). Next, the team carefully examines what they have learned about the behavior and its context in order to determine its function(s), the antecedents that trigger it and the

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[5] A programming team can be defined as a group of caregivers usually within a particular school, but sometimes across school and home bounds who are all working together to diagnose and to address behavioral or educational concerns. These tend to include teachers, para-professional educators, and behavior specialists and can include family members and outside therapists (speech, etc).

[6] These graphs are typically based on data collection via ABC forms in which caregivers denote the observed antecedent (A), behavior (B) and consequence (C) alongside other contextual information, such as time of day and activity. A scatterplot then is typically the plotting of these behaviors against days of the week and times of the day. An ABC chart is usually constituted as a bar graph in which the coincidence of particular antecedents (A) or consequences (C) with a behavior (B) are outlined.

consequences that maintain acting-out behavior. Finally, they develop an intervention plan from the FBA. In some cases, the function may be verified using functional analysis in which the child is presented with stimuli in a controlled manner to test the hypotheses about function determined during the assessment period. Also, in some cases, the intervention plan itself may be tested over a period of time using similar assessment techniques.

There are several commercial software packages for behavior assessment and planning for children with special needs. They are lacking in many ways, however, and caregivers sometimes adapt their own versions of software out of sheer frustration. Behaviorists local to Atlanta reported using a system developed at the Kennedy Krieger Institute that has been passed casually around by interns and graduates of the Institute for approximately ten years. It allows a dedicated observer to log data using configurable function keys on a standard keyboard. Data collection is focused on the existence of a particular "session" in which a child's behavior is monitored for a set amount of time with minimal report generation capabilities. Those caregivers who used this system primarily reported exporting the data to another access interface such as Excel for analysis. Architext Behavior Action Planner (AGS Publishing 2005) allows behavior specialists to manually enter a variety of information and prepare reports using predefined templates and automatic generation tools. The focus is more on the high level behavior assessment record than on the details of particular analysis sessions. *!Observe* (Functional Assessment Intervention Program) allows caregivers to track data with either a PC or PDA and analyzes responses to questions and automatically suggests strategies for behavior management (Hofmeister *et al.* 1999). Caregivers reported that the PDA was too cumbersome and the suggestions were less helpful than they expected.

2.2 Early Capture and Access Research Visions in Computer Science

In his 1945 *Atlantic Monthly* article, Vannevar Bush describes his vision of the *memex*—a system for storage of every artifact encountered in daily life and the associations between them (Bush, 1945). Storage of important media coupled with meta-data is perhaps the first vision of a generalized capture and access system. Bush also envisioned a variety of wearable and mobile devices to support recording of details of daily life, such as cameras worn by scientists to capture pictures during experiments and a potentially mobile machine to record audio dictations. The goal of these envisioned devices is to support the automated capture of common everyday experiences for later review, a goal echoed in many research projects since.

Douglas Engelbart described how technology can be used to augment human intellect (Engelbart, 1962) and to "leverage [a group's] collective memory, perception, planning, reasoning, foresight, and experience into applicable knowledge," a concept he termed "Collective IQ." This idea of Collective IQ is significant when considering capture for the purpose of problem solving in a group setting with caregivers of CWA. If the entire care team, usually comprised of teachers, parents, professionals, and administrators, can together use data to diagnose and to treat CWA, the group's knowledge and abilities increase exponentially.

As inspirational as Bush and Engelbart's visions have been, they still focused on applications with and through centralized computing platforms. Mark Weiser, on the other hand, described similar visions in a distributed, ubiquitous model away from the desktop. He describes a vision of *ubiquitous computing* in which technology is seamlessly integrated into the environment resulting in useful but "invisible" services available to humans at all times (Weiser, 1991).

Although Weiser's descriptions of these applications were vague, there were real applications behind the concepts that he described. Weiser's article actually previewed many ubiquitous computing projects conducted at Xerox PARC under his supervision as well as those at Xerox's research facility in Europe (Rank Xerox Research Center, RXRC). A collection of applications at the time addressed using automated capture to augment retrospective and prospective memory. These included:

- Forget-Me-Not (Lamming and Flynn, 1994) for continual capture of locations and persons encountered by the user and the user's workstation activities
- Pepys diary (Newman, et al., 1991; Eldridge, 1992) for collection of video snippets associated to locations. Similar to the use of cameras in the environment in our Experience Buffers architecture, the Video Diary relied on a video network (Buxton and Moran, 1990) throughout the office to take a snapshot of a person using a camera closest to her location when a significant episode is recognized.
- NoTime for note-taking through synchronized capture of a user's handwritten notes with audio and video of a meeting (Lamming, 1991).
- Marcel for monitoring paperwork activities using overhead video cameras (Newman and Wellner, 1992).
- Tivoli (Moran, et al., 1997) for capturing important information from planned meetings.

- Where-were-we (Minneman *et al*. 1993) for accessing data from captured streams *during* a meeting or much later.

From this work, the researchers developed guidelines for capture in everyday life including the need for sensing and capture in the physical environment, support for both automatic and manual data capture, and the development of access interfaces that facilitate finding relevant information. Many of the research projects since have addressed the issues indicated by these guidelines, but have relied on the inherent structure of the activities being captured to reduce concerns about recording in a broad range of environments, to reduce concerns about the risks of both automated and manual capture, and to simplify the problem of recording and later accessing all of the relevant information and only the relevant information.

2.3 Dimensions of Capture and Access

Weiser's writings and the projects at Xerox PARC and EuroPARC have inspired many ubiquitous computing researchers to investigate the problem of capture and access. Truong *et al.* reviewed the state of the art in ubiquitous computing research of this problem space in 2001 (Truong *et al.,* 2001) and more recently in 2005 (Truong, 2005). Truong *et al.* defined five dimensions of the capture and access application space that can be used to characterize this application design space:

1. ***Who*** the users are,
2. ***What*** is captured and accessed,
3. ***When*** capture and access occur,
4. ***Where*** capture and access occurs, and

5. ***How*** capture and access are performed.

Additionally, Richter *et al.* (2005) proposed another significant dimension for measuring capture and access applications, that of the level of need of accessing the information. She concluded that people rarely review meetings, and thus, the need for that information must be significant enough to overcome any capture and/or access barriers.

For this thesis, I define structured activities for capture as those for which most or all of those dimensions can be defined prior to the experience. These settings are predictable, usually in known locations, with regular participants where either the activity or the location itself provides a high enough degree of structure to the capture experience that these contextual clues can be easily added to the captured data to ease access at a later time. In this review, I primarily focus on those applications that target environments similar to those I target, either in level of structure; that is, those applications for which some or all of the dimensions can not be defined easily beforehand.

2.4 Informal and Unstructured Capture and Access

When not expecting to capture activity, as is often the case with impromptu but significant moments, people often lose the data they would have liked to record. When they do manage to record this information, the lack of preparation for recording as well as the lack of structure to the recording bring up a variety of social and technical concerns inherent to informal settings, including concerns about too much data and infringement upon privacy and difficulties with accessing the right information in a large stream of unstructured data. Researchers have addressed these concerns in different ways. In this section, I discuss projects focused on capture in these informal settings and how the approaches to addressing these issues vary from our approach.

2.4.1 Design Activities

Groups of designers often collaboratively brainstorm, browse artifacts from previous projects or from the Internet, and create new artifacts (Ionescu *et al.* 2002) while creating a new design. In early stages of design, these artifacts are often arranged and used in a shared group workspace. Thus, research projects focused on knowledge capture for design teams have primarily utilized properties of the physical space, including its appearance, to provide extra structure to inherently unstructured design activities.

The WorkspaceNavigator from Stanford (Ju *et al.* 2004) captures student project group meetings in a dedicated physical workspace instrumented with cameras that capture snapshots of the room, whiteboard, and physical objects while recording screenshots from some of the designers' computers. To support capture of unexpected moments, the researchers chose to capture information all of the time. Although participants spontaneously mentioned concerns about privacy and requested control of recording, they rarely took advantage of the ability to pause and to resume recording. The authors hypothesize, and I agree from my experiences with capture in other domains, that this discrepancy is not due to the lack of concerns about privacy during actual system use but rather about the tendency of people to forget they are being recorded even after they have been explicitly notified. Furthermore, participants in the WorkspaceNavigator studies requested the ability to remove information from the system after the fact. These findings support our view that users are very good at noticing both those moments that are significant and should be saved and those moments that should be deleted *after* their occurrence but are not particularly good at predicting when they might or might not want capture services *before* the event of interest. Their use of an iButton[7] to provide a manual index into the capture stream is similar in concept to the idea of using a button to trigger retrospective archiving of a short buffered stream of captured information, differing of course in whether the data would be captured at all without the button press.

Like in other types of design, ideas of a future web site structure often are collected and arranged through paper Post-It notes on large walls or tables in the early stages of web design. Use of physical artifacts in a large space affords the persistence of these large amounts of information for as long as needed. The Designer's Outpost application supports a virtual representation of this practice using two digital cameras and a rear-projected electronic whiteboard to bring the physical artifacts into the digital world (Klemmer *et al.* 2001). A digital whiteboard replaces the walls and tables used currently but its use affords the addition of other notes and hyperlinks to the original design. This model of capture allows the designers to continue to work in a relatively unstructured way as is current practice, but requires use of a very specific design space (Klemmer 2002). In this way, the physical location scaffolds the capture process to create a more structured capture activity. Furthermore, users access the information in using structure from existing practices: sitemaps, generated storyboards, and page schematic representations. Thus, addition of structure either from the current processes or externally generated can ease the use of capture and access systems for inherently informal and unstructured activities in the natural environment.

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[7] An iButton is a microchip similar to those used in a smart card but housed in a round stainless steel button of 17.35mm x 3.1mm and manufactured by Dallas Semi-Conductor.

2.4.2 Impromptu Meetings and Office Work

Serendipitous conversations present a unique challenge for capture systems of not knowing who the participants are nor when the conversations could potentially occur nor what the structure of the information discussed is (like with an agenda in a scheduled meeting). Many of these discussions happen at or near whiteboard surfaces. The DUMMBO application used a non-projecting SmartBoard with an attached sound system to capture informal and opportunistic meetings (Brotherton *et al.* 1999). When a person uses a pen to write on the board, DUMMBO automatically begins to capture the writing and discussion. Furthermore, if two or more people are known to be near the board, recording of the conversation will occur even if no writing appears on the electronic whiteboard. Users can access their personal collection of unstructured meetings through a web interface through which they can browse or search for meetings using the context of the meeting (who was there, when and where it occurred).

Xerox PARC's Flatland project (Mynatt *et al.* 1999) focuses on the capture of informal activities within a private office, using time as the primary index into those activities. The Kimura project supports capture and access of more structured activities in the office, such as actions performed on desktop computers, to assist the user in managing multiple "working contexts" (MacIntyre *et al.* 2001). Specifically, Kimura allows the user to switch between working contexts by moving different tasks throughout the office.

2.4.3 Continual Personal Capture

Many research systems have previously focused on personal capture of live experiences, with varying levels of manual (explicit) and automatic (implicit) capture. These projects attempt to provide individuals with tools for remembering details from regular activities, both structured and unstructured. In this section, I describe several of these projects and their approaches to capturing relevant information in socially appropriate ways and providing access to this information later.

The MyLifeBits project (Gemmell *et al.*, 2002), originally known as CyberAll (Bell, 2001) explored issues related to storage and retrieval of all of the personal media that a person would encounter in a lifetime. As part of this work, Bell estimated the requirements for disk space for this entire media, claiming that 40GB would be sufficient to hold a lifetime of reading, presentations, and audio recordings. Notably absent from these figures are video recordings, which would certainly require a much larger quantity of disk space[8].

Forget-Me-Not was arguably the first application to demonstrate the concept of continuously capturing a mobile user's experience in an instrumented capture environment—the office (Lamming and Flynn, 1994). Since that work, many other research projects have revisited the same concept in spaces rich with information, such as museums and academic conferences. Want *et al.* (2002) have also explored this concept but from a mobile infrastructure standpoint with the Personal Server project, a device that users can carry with them capable of storing and providing access to all their personal information as needed through available devices and local wireless connections. Want and his researchers are currently investigating use of the Personal Server in a variety of capture domains including health and educational record-keeping with CareLog and applications like it.

[8] The data required for this dissertation, including many hours of video recording, requires more than a half a terabyte of storage alone.

ButterflyNet is a mobile capture and access system for biologists and other scientists working in the field (Yeh 2006). Using technology-augmented notebooks and other devices, scientists can record and later find handwritten notes, photographs, sensor readings, GPS track logs, and other research content. Data recorded by the scientists manually is integrated automatically with the other data to provide structure and metadata with which to search and explore findings later.

2.4.4 Buffering Capture Streams for Quick, Near-Term Review

Minneman *et al.* (1993) explored the use of near term access of information captured during structured activity, meetings, with the Where-Were-We application, a service that captures video of the meeting activity. This service allows users to access data from the captured streams *during* the meeting or much later. Prior to this work, however, Hindus and Schmandt (1992) created a near-term audio reminder service, known as Xcapture that provided a "digital tape loop" of audio for a single office and later telephone conversations through a regular PC interface. Dietz *et al.* later provided a similar capability using the phone device itself as the interface for interacting with the captured audio (Dietz and Yerazunis 2001). The application allows the user to catch up to the live conversation by speeding up the playback using audio processing techniques. Using the Motorola i730 phone, along with other researchers in the Ubicomp Research group at the College of Computing at Georgia Tech, I explored the potential usability, usefulness and acceptability issues involved with the user always being able to review audio from her recent past on a mobile phone (Hayes *et al.* 2004, Patel *et al.*2007). The Personal Audio Loop application, PAL, continuously records audio from the phone's microphone and stores the audio for a user-defined amount of time, allowing a user to replay recent audio snippets.

Video content also can be buffered, as demonstrated by the Where-Were-We application. The SenseCam application from Microsoft Research takes a photograph every few seconds to create a digital record of experiences (Gemmel *et al.* 2004). The StartleCam application buffers video to capture interesting images of a user's surrounding after the system has detected a change in the user's emotional state (Healey and Picard 1998). To compensate for latency caused by the sensor as well as the processing of the data points, StartleCam buffers a very short amount of video content to allow the application to grab images from seconds ago, when the trigger point occurred. Rather than providing video replay and access capabilities, the What-Was-I-Cooking application uses a collage of still images to show recent activities in the kitchen (Tran and Mynatt 2003).

I was motivated by all of these applications in the development of the Experience Buffers. Whereas each of these applications buffers a particular media, *e.g. video*, I propose that we can best take advantage of the affordances, both socially and technically, of selective archiving by providing an extensible architecture that can include or exclude any of these media types depending on the application. In both CareLog and BufferWare, however, I primarily focus on audio and video capture leaving room for the addition of other services in future revisions if believed to be necessary or significant to the domain problems represented by these applications.

2.5 Technologies for Behavioral and Educational Record Keeping

Much research addresses helping individuals manage their own health through assistive technologies, applications for aging in place, and large scale medical integration efforts including the vision for a single digital medical record. In education, attempts at advancing the way children are diagnosed and monitored at the local level as well as through federal mandates like "No Child Left Behind" (No Child Left Behind, 2001) have changed the way records about a child's diagnosis and progress are handled, particularly for special needs but also across the spectrum of abilities. Often, the focus in medicine and in education can be in capturing, sharing, and providing reflective access to behavioral data, because a patient or student's behavior is externally manifested in an environment and thus can be measured, catalogued, and analyzed. In this section, I discuss some of the relevant commercial applications for data recording and review some of the relevant research projects for the assistance of capturing, visualizing, and sharing data about a patient or student in the medical and educational fields.

2.5.1 Medical and Eldercare

Physicians have long used patient-recorded data to assist with diagnosis of often-mysterious symptoms. For example, when attempting to diagnose a potential food allergy, doctors may request that a patient keep a detailed food diary to be analyzed alongside a symptom diary in which patients record everything eaten and every symptom experienced. As tele-health technologies have become more prominent, the tools used to gather this sort of everyday information have improved. As another example, in diagnosing heart abnormalities, cardiologists often employ mobile event recorders such as Telescan (2005) asking patients to push a button that allows for the recording of detailed medical data when the patient feels symptoms not just when the patient is in the office. The Point-Of-Care Engineering Laboratory at Oregon Health Sciences University focuses on developing new technologies that can help monitor and diagnosis cognitive decline in the aging population early by inserting these technologies into everyday activities (T. Hayes *et al.* 2003).

The Careview project (Mamykina *et al.* 2004) focuses on the capture and access of medical information to support work practices and information needs of homecare nurses. A field study of nurses led to the development of interface design guidelines for displaying clinical data including temporal visualization, integrated data gathering and data analysis, and hands-free speech-driven operation. Similarly, the LifeLines project (Plaisant 1996) focused on visualizing patient data over long periods of time.

Other researchers have examined the idea that data captured about a patient (or child with special needs) might need to be shared with all of the caregivers for that person. In the Computer Supported Cooperative Care and Proactive Health projects from Intel, (Consolvo *et al.* 2003; Morris *et al.* 2003), researchers have utilized a variety of displays to reflect back information about a person as well as to share that information with her caregivers. Similarly, the Digital Family Portrait (Rowan and Mynatt 2005) project focused on communication of behavioral data about an elder with one significant caregiver as part of a long term deployment of a working sensor and display system. The CLever Project at the Coleman Institute at the University of Colorado (Coleman 2005) strives to develop computationally enhanced environments to assist not only people with a wide range of cognitive disabilities, but also their support community. As part of this effort, there are a variety of projects, but most relevant to this work is The Evaluation

Assistant project (TEA) in which non-expert caregivers can evaluate individuals with disabilities and their assistive technologies. Dawe also detailed the factors that are influential to the adoption of assistive technologies for families of children with developmental disabilities as part of this project (Dawe 2006). As another example, Lin *et al.* examined the ways reflection of not only the individual's activity, but also the activity of a competitive group can affect the ways people think about and enact exercise routines (Lin *et al.* 2006).

Finally, researchers have also explored the way that information about an individual's health and behavior reflected back at them can alter the ways they behave or they ways they think about their own health. Mamykina *et al.*(2006) explored the ways patients with diabetes think about their own health by providing them extra information about blood sugar levels and other data using mobile technologies.

2.5.2 Educational Settings

In addition to capture and access of classroom activities for student use, researchers have examined recording of classroom and one on one instructional settings for instructor analysis and record keeping. Rosenstein provides an extensive review of uses of video technologies in social science research which can include observation, data collection, and analysis (Rosenstein 2002). From this review and my own search, I note projects of particular relevance to this work. Use of video to record best practices for teachers can help identify those tacit differences in behavior that make one teacher significantly more successful than another (Leinhardt, 1986). In other schools, video has been used as a way to conduct performance assessments for hiring and promotion of teachers (National Evaluation Systems, 1996). Others have suggested that teachers do self-evaluation using video and possibly computer technology to augment the video record (Ives 1989; Haertel 1993). Furthermore, Pailliotet found that teachers were able to "see" those things of which they had not been aware during an actual classroom interaction and therefore make better judgments about the children's behaviors and their own (Paillotet 1995).

Several projects have explored use of video for assessment of programs and interventions in childhood education. The VideoShare project focuses on use of video in caring for children with disabilities (Walmsley and Neilsen 1991). It encourages use of video for communicating between schools and families, increasing the effectiveness of the care team, and improving therapeutic interventions. The Walden Monitor (White *et al.* 2003) is a prototype of a mobile application that supports the capture of handwritten notes (on a TabletPC) synchronized with captured video as part of a prescribed, timed observation process. The process of recording this information was already a detailed, structured practice that required a dedicated observer. Thus, the addition of capture technologies did not disrupt the practice and at the same time provided the ability to share and review the data more easily. Abaris (Kientz *et al.* 2005) is an automated capture system for the recording of instructional data during one-on-one Discrete Trial Training (DTT) sessions (Heflin and Simpson 1998) usually performed at a table top or in another defined area. The very nature of DTT makes it an ideal candidate for exploring capture and access applications for recording data about individual student progress. Therapists use controlled and conditioned training sessions to help children with moderate to sever disabilities learn new skills. In a pilot deployment study, Kientz *at al.* found that the high level of structure inherent to the therapy provided useful indices into richer video data that made that data both accessible and useful in ways it had never been before (Kientz *et* *al.* 2005). Furthermore, progress through DTT can often be slow and hard to track. Because new intervention and instructional plans are created through the careful analysis of detailed annotations about a child's performance on particular tasks, the ability for therapists to easily access this data is a capability that was needed. Abaris supports a problem that includes a high inherent level of structure useful in capture applications. Furthermore, this domain problem includes a high need for recording, accessing and understanding instructional data that generally indicates a high likelihood for adoption as suggested by Richter (2005).

2.6 Summary, Perspective on the Literature, and Relevance to this Work

2.6.1 Summary of Literature Reviewed

There is significant documented value to recording throughout history. Educators have similarly recognized the importance of noting progress and using evidence in diagnostic and curriculum development activities. With concern over educational outcomes, the need for regular noting of activities in special education has become pervasive.

The early visions of capture and access have fed directly into this work, as I explored the particular design space of natural environment capture and access. Many research systems have previously focused on personal capture of live experiences, with varying levels of manual (explicit) and automatic (implicit) capture. People need to document activities in everyday life making the when and where dimensions of Truong's framework potentially any time and any place. At the same time, one of the major challenges to this work is that social and legal constraints coupled with technical limitations also make fully automated capture at any time and in any place unrealistic, regardless of who is doing the capturing or how much they need the data. I also outlined other research efforts that have used notions of buffering as well as those efforts, both commercial and research, in capture and access and in medical and educational record keeping and functional behavior analysis. Finally, I outlined Functional Behavior Assessment and its origins, a best practice I sought to support in schools using capture tools.

2.6.2 Reflexive analysis of my standpoint

Given the ethnographic nature of much of this work and the potentially contentious stance from which much of this work originates[9], it is also important to present a brief summary of my own orientation to the domain problems. Furthermore, I one must consider the literature described in this dissertation set against the backdrop of my own history and personal experiences. "The data which ethnographers use is a product of their participation in the field, rather than a mere reflection of the phenomenon studied, and/or is constructed in and through the process and analysis and the writing of ethnographic accounts." (Hammersely, 1992)

I am the youngest daughter of two professionals who have by most Western and American standards been highly successful in their lives. They both earned doctorates in education (Ed.D.) with emphases on counseling, psychology, and education. I was raised in an upper middle class home in "college towns," a bit of a departure from my elder siblings who more directly experienced the lean years in my parents' early careers. Despite any financially difficult times that they or I have ever experienced, I would argue

[9] This stance is that the overall benefit to a particular child and to society in general of recording as part of care activities overrides many if not all objections by others to that recording. This stance also relies upon a belief that record-keeping is an effective tool for teachers, parents, and other caregivers in caring for and supporting the learning of children with special needs.

that success was always mostly assured for us each, given our positions as white, educated Americans. I attended private school from the time I was twelve years old, a choice that was difficult for my parents to make given their firm ideological beliefs in public education, but the move to Georgia from the North and the vast differences in quality of public education in these areas necessitated such a move, from their point of view. It never occurred to me that I would not go to college, and it never occurred to me (not seriously, anyway) that my future children would not either, until I began my work with children with autism, many of whom were born into similar households.

I was fortunate enough to be influenced profoundly in my life and in my work to pursue specifically an interest in autism by two very important people, my advisor Gregory Abowd and my sister Jessica Little. My relationship with Gregory's family, which includes two children with autism, made tangible and real the problems many face when caring for children with autism. This relationship also made entrée into this community much simpler. Likewise, my sister's work as a special education teacher similarly inspired me and made the needs and concerns of teachers of children with autism tangible and real.

I was raised with clear beliefs about right and wrong behavior, from the minor issues such as talking with your mouth full to more significant points, and I have always strived to please others through appropriate following of these cultural customs. I am commonly taken aback by those who do not follow them, and I find that it is this cultural stance that tends to make it easier for me to deal with those individuals with severe disabilities than those with minor. Those with more severe disabilities operate further from the borders of these cultural norms, making it easier for me to identify and appropriately respond to their particular needs and different abilities. I agree in a philosophical, removed sense that society should adapt to those individuals who are different (such as people who are high functioning with an Asperger's diagnosis). Furthermore, I understand logically why some individuals thus argue against behavior modification. In practice, however, I find I require intentional reminding of these logical values when I more automatically wish everyone followed the customs I was taught, that is that they have "good manners."

In certain cases, both philosophically and practically, I believe that an important goal of caregivers must be to modify behavior. These cases are those that constitute what some educators refer to as severe behavior or even diagnose as severe behavior and emotion disorder (SEBD). A example of an SEBD behavior is any in which the individuals present a physical danger to themselves or others. Appropriate behavior modification in these cases may help them to avoid institutionalization or even help them to live independently or semi-independently, greatly increasing quality of life.

Born and raised in the United States, I am influenced by the collective American consciousness with regard to capture technologies. In the United States, a heavily industrialized nation and one of the leaders in Internet and communications technology development and use, many public areas are recorded for security purposes and tourists and other people commonly take digital and analog recordings. However, these heavily recorded environments have not taken on the scope of some initiatives in Europe, such as CCTV in the United Kingdom. The Bill of Rights, among other documents in American history, takes great pains to protect American privacy and individualism, an important consideration of the culture from the beginning. Furthermore, American media, which is at least theoretically representative of American views, often describe frightening stories about video capture, including voyeurism and other "caught on tape" scenarios regarding such technologies as elevator (lift) security cameras.

I have very few concerns about privacy or even security and safety in the traditional American sense. Again, colored by my relatively safe and straightforward upbringing, I tend to view most audio and video capture as primarily for the greater good and unlikely to be used against me[10]. I do, however, have many concerns about self-presentation, an attribute that is easily exemplified by my careful perusal of Flickr after most events at which I attend and my insistence upon the removal of unflattering pictures. Fundamentally, I believe that the ways media capture can be used for benefits (security, production of scientific and practical knowledge) greatly outweigh the negatives. Furthermore, I hold as a core belief that while designers must explore the ways in which their technologies might be used both for good and for naught, they cannot ultimately control such adoption, and it would be arrogant to assume that they can. Societies and cultures the world over have always adopted and adapted new technologies to fit their needs, and in return these technologies have changed our world.

2.6.3 Relevance of the Literature to this Work

I present two case studies in this dissertation, both explorations of the uses of a specific capture technology. One, however, is also an example of an in-depth study of

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[10] As an aside, I have lately been more concerned than in past years, primarily due to the current federal administration and recent laws, such as the Patriot Act. I expect these concerns to be short-lived, but they should be noted given the timing of this dissertation.

the influence of technology[11] upon particular educational process, functional behavior assessment and other record-keeping practices both those already in place and some that are new due to the introduction of new technology. An initial goal of this work was to understand the needs of caregivers of children with autism, particularly around natural environment record keeping. From this goal developed the further aims to design and develop technological supports for functional behavior assessment, including the concept of selective archiving. Thus, it is important to understand the ways in which record keeping and technology fit into educational frameworks, both those developed within education and those from other social sciences.

Once the technology was designed and developed, it became imperative to explore its use and reactions to it in a very different environment. It is only by examination of both of these case studies that we can begin to reflect on some of the larger issues inherent to a solution for capture that provides both automatic and manual features for recording and deleting.

In this work, I address the needs of individuals capturing information in unstructured, often informal, and potentially sensitive contexts. From experiences with these situations, the applications for them, and the use of those applications, I specifically address the holes in the design space surrounding capture of experiences in unstructured and informal settings. I describe the ways in which selective archiving addresses these holes and the areas that still require substantial exploration and understanding.

[11] I use technology in this sense to include a wide variety of tools, including the original paper-based forms used by teachers in their classrooms.

CHAPTER 3

FORMATIVE STUDIES OF CAPTURE

In this chapter, I describe my initial interest and motivation to study note-taking and unstructured, unplanned capture experiences. From this initial interest, I describe a simple survey study undertaken to examine some of the problems of this type of note-taking in the natural environment. I then describe in more depth two studies that began at nearly the same time: formative explorations of a personal audio-based memory aid and in-depth field studies of the needs of caregivers of children with autism. This second effort became a much longer-term endeavor than the first and resulted in a second detailed exploration of the particular needs of the entire community of caregivers and larger group of stakeholders. I describe these studies as well as the particular needs, considerations, and tensions they revealed both for the specific problem of caring for children with autism and the more general note-taking problem in unstructured natural environments.

3.1 Initial Interest in Unstructured Settings of Note

Despite advances in personal information management devices, people increasingly have difficulty documenting, prioritizing, and organizing daily tasks, not to mention remembering all the details of daily life (Blanford and Green, 2001). I was motivated by my own experiences both with management of day-to-day information and with attempts to document health issues as prescribed by my physician. I wanted to understand the ways in which people document these short important thoughts, and so I queried people about their current practices and unfulfilled needs as part of a short project in the fall of

2002. I studied how users currently record, organize, and access these small snippets of information. Although this work resulted in only a minimal research contribution, I include it here as a first step towards a research agenda focused on recording of information from everyday settings. Many of the trends that would repeat themselves throughout my formative and summative studies of data recording, I observed first as part of this project. In this section, I detail some of those findings.

3.1.1 The Importance of Physical and Digital Artifacts

People want the conveniences of both physical and digital artifacts. When asked which mechanisms participants "use for jotting down notes, ideas, or to-do items," 68% of the mechanisms cited by participants included handwritten input on a variety of physical artifacts, including notepads, calendars, and Post-It™ notes. Almost all of the participants who owned a PDA, for example, also mentioned using handwritten mechanisms such as scrap paper and notebooks. While traditional writing is appealing as an input method, people also mentioned wanting the benefits of information in digital form, including an increase in the perception of longevity and the ability to reorganize information. Of the participants with both digital and analogue methods available, 44% reported copying information from handwritten to digital format. Other responses expanded further on the desire for digitization and the ability to transfer between digital and analogue modes. Some people referred to the problems of carrying too much paper as well as the ease with which their paper notes could be lost or destroyed. When I asked participants to "list three things you'd like to improve about your current note-taking process," the most frequently mentioned items were better organization (12) and digitization (7). These results suggested that a focus on using traditional inputs like pen and paper to a digital repository might be ideal. This model turned out not to be appropriate for in-school behavior management in which carrying even a notepad and pen would be too onerous a task but Kientz *et al.* (2005) were able to use this model with in-home and in-school therapy sessions for a similar population of children but for different goals.

3.1.2 Flexibility

The most often cited uses of recorded information included day planning (35%), tracking tasks (26%), and storing important dates and numbers (12%), all of which require a great deal of organization and prioritization. Participants indicated a wide variety of methods used for organizing the information they recorded, including chronologically, alphabetically, and by priority. Participants also listed transcription into different forms as a way of organizing their information. For example, some participants used only handwritten formats but copied smaller pieces of paper onto larger ones once the information had reached a certain age. They then organized these notebooks with filing methods that often also changed based upon the age and type of information being stored. Not surprisingly, I observed a similarly diverse range of schemes for organization of recorded information when probing parents and caregivers of children with autism.

3.1.3 Ubiquity

One of the most commonly cited features of any kind of note taking strategy is the need both to record and to access those notes anywhere and everywhere. Further compounding this requirement, the various settings in which a person must both capture and access this data may require very different interfaces while the information needs may remain the same. As part of this early survey, I identified three specific environments that require better support for recording information:

- difficult social situations and contexts,
- while in motion or traveling, and
- challenging physical environments.

A socially inappropriate context can be an event (movies, concerts, etc) or a one-on-one conversation in which it would be considered rude to pause to document the goings on. This situation is one of the motivating uses for the Personal Audio Loop (PAL) project described in Section 3.2. For example, when you meet a person at a party, it would be socially awkward to write that person's name down, but it is also generally considered inappropriate to forget it or to ask them again just a few minutes later. Additionally, there are times that might be inappropriate to record due to the requirements of the primary task, such as when one's job (*e.g.* caring for a child or teaching) must maintain priority over documenting, even when the note is short.

Traveling includes any time that the motion of the user requires so much attention that distraction could be dangerous. For example, many people noted needing to record things while walking or driving to work, a time that was often convenient for reflection and day planning. As is described in Section 3.2, this scenario was not necessarily one of the original motivating ideas behind PAL, but some people did use the system in this manner. In caring for children with autism, caregivers often reported being asked to document or wanting to note something when in the car or bus with a child or even when walking, noting the physicality of the motion as a huge barrier.

Challenging physical environments are those in which recording information requires overcoming too many obstacles to seem worthwhile. For example, many people noted that ideas that come to them while lying in bed get missed, because they do not keep a notepad near the bed and choose not to get out of bed, hoping instead to rely on their memories. Similarly, in homes and schools, caregivers of children with autism often report being unable to find or to access the notebook (or notebooks) in which they are meant to record this information and are too busy with the primary task of care to pause and track it down, much less write in it. Some caregivers have developed some workarounds to this issue, but these are still insufficient for their needs in most cases.

Many participants in this survey noted not only the need for appropriate ubiquitous interfaces but also for constant availability of all of their information. I expected this particular need to vary somewhat based on other factors in the other domain problems studied. For example, in the schools, I anticipated that records could be confined to the school and school hours, unlike in a home setting in which they would be likely to be needed at any time. As it turns out, teachers also needed to bring their data with them outside of the school, because the limits of their working time required that proper assessment of the information they had recorded be done over weekends and in the evenings in some cases.

3.1.4 Transcription and translation of information

People often convert data from one format to another to make it more useful for a particular task. For example, teachers often convert narrative or text-based notes into quantitative results by categorizing this information. After this conversion, they are able to look for trends in the data numerically. Furthermore, participants in this initial survey noted that they would also transform information in a variety of ways including transcribing audio notes or copy information from emails into a more general note area or to do list. In fact, 73% of the participants reported transcribing information in some way.

Currently available technologies for automatic conversion between formats may be inadequate given the highly personal nature of many records, but particularly those that are short and taken in unstructured settings. Survey participants reported using individual short-hand and abbreviations, making handwritten to digital transcription difficult in the general case. Audio transcription would be hindered by individual speech nuances. In fact, in all of the subsequent explorations of this problem, including the purel audio-based PAL, I avoided the issue of audio transcription altogether, relying instead on the human ability to quickly recall or surmise the important information from the audio without full transcription.

3.2 The Personal Audio Loop: A Near-Term Audio-Based Reminder

In the Fall of 2002 and early Spring 2003, I worked on a project known as the Personal Audio Loop (PAL). In this work, we explored everyday conversational breakdowns and short-term memory lapses. We worked to understand the ways in which an audio-based ubiquitous (in this case, mobile) memory aid could support these particular issues. When considering the varied ways in which an audio reminder service might be enacted, solutions along the spectrum from always on automatic capture all the way to manual recording were considered. Manual recording is primarily what people have available to them now, in the form of digital audio recorders or the audio memo features available on many PDA and mobile phone models. Fully automated recording follows a similar model to many other capture and access applications previously considered. Given the particular sensitivity of audio in everyday life and feedback from people outside of our research group, we believed that continual recording would not be appropriate for many situations. In the end, we settled on a buffered solution, or a "loop" as the name of the eventual software implies. The project had been in varying stages of prototype design and development when I joined it. Ultimately, once the looping decision had been made, we chose to explore other questions while designing a technology that would be likely to survive a real life deployment, in terms of physical and technical robustness and acceptability. These questions included:

- *Usefulness*: Though motivated by observations from everyday life, how often and in what situations do people actually need a near-term audio memory aid?
- *Ubiquity*: What parameters of such a service would make it available everywhere and every time someone needed it?
- *Usability*: How should the service deliver functionality to maximize its benefit and minimize its distraction?
- *Social and legal considerations*: What social and legal concerns might prevent the successful deployment of an audio recording application for everyday life?

The design and evaluation processes for PAL involved a series of formative studies that led to the design of a self-contained service integrated into a commercial mobile phone handset. Although the decision to build a local (that is, local to one device rather than distributed) solution for PAL came early, it resulted naturally from an exploration of the usefulness, ubiquity and socio-legal concerns for this problem, and was justified by our findings. These findings are described in depth elsewhere (Hayes *et al*. 2004 Patel *et al.* 2007), but I describe some of the relevant findings in this section.

Based on early interviews and our intuition, we determined that the platform for PAL would need to be mobile, powerful both in processing and development environment, include buttons, and an external or attachable microphone. The mobility, ubiquity and performance of mobile phones make them an appealing platform for this application, but only certain phones support the required capabilities. Our choice was the Motorola iDEN i730. We then conducted two formative studies to answer questions of the feasibility of using a mobile phone as the interface to an audio-based memory aid and to characterize the frequency and situations of use in everyday life.

3.2.1 Laboratory Study of PAL Interface

The first formative study of PAL was an in lab study using a scripted dialogue and controlled questions participants were asked to answer using the recorded audio. Eighteen people participated in the lab study. All participants were able to navigate the audio well enough to answer our questions. They commented that the device was easy to use with one hand ($\mu = 6.95$, $\sigma = 0.2$, 7 being the highest), and small enough to carry at all times ($\mu = 5.42$, $\sigma = 2.0$ out of 7). They could clearly understand the audio even in its highly compressed form ($\mu = 6.5$, $\sigma = 0.9$, with 7 being "strongly agree"). With an audio buffer of 15 minutes, participants required an average of 34.8 seconds ($\sigma = 22.58$) to find responses for questions that were known to be in the in the recorded audio while talking aloud about their actions. Thirteen out of the eighteen participants used PAL without the visualization, preferring an eyes-free interaction, indicating to me that the snippets of information might be small enough for future interfaces to capture buffers to have minimal visualizations. Although inquiring about privacy was not a goal of this study, ten participants raised spontaneous concerns regarding the social acceptability of a continuously recording system. The most common sentiment expressed indicated that participants were less concerned about recording their own voice than their conversation partners'. This result indicated to me that further exploration of the reactions of people generally to the idea of buffered capture services, particularly in public spaces, was warranted.

3.2.2 Diary Study of Potential Uses of PAL

The second formative study of the PAL project was a diary study focused on probing the times and situations in which participants might have a use for PAL. Twelve experienced mobile phone users (5 female, 7 male, ranging in age from 22 to 60 years) participated in the study. Participants' occupations spanned a spectrum of domains, including a psychologist, finance manager, realtor, car dealer, consultant, professor, and full-time homemaker. I demonstrated a fully working version of PAL to each participant during their introductory interview and instructional session. I also asked each of them to carry a small pocket-sized diary and record an entry in it for each incident during the following week when they would have needed or liked to have used the PAL service. Each page of the diary contained a simple form to complete for the potential instance of use, streamlined after an initial trial period. Each form in the diary included space for describing the content of the audio to retrieve, when and where the incident occurred and whether any persons unrelated to the conversation were nearby. Participants also estimated how far in the past the salient audio content was and rated how important it was to retrieve that information. At the end of each week, I collected the diaries from participants and conducted semi-structured interviews to examine in detail up to six diary entries per participant per week. With the help of other members of the research team, I designed specific questions to probe these entries in depth. These questions included privacy-related questions such as the kind of information being sought, the distance of unrelated third parties from the participant and their assessment of the social appropriateness of using the device in the specific context. They also included questions about what was going on in the situation and how likely they would have been to be able to use a memory aid in that setting. I then gave each participant who chose to continue for another week a new empty diary to again record incidents. At the end of the study, I conducted semi-structured interviews with all participants. The weekly and summary interviews allowed for the clarification of misunderstandings in the entries as well as probing of particular issues, such as privacy concerns, that were not easily gathered in the chosen diary form factor.

Twelve people participated in the first week, eleven continued for the second, and eight in the third, for a total of 31 participant weeks and 109 incident reports. Participants reported an average of 3.5 ($\sigma = 2.7$) inci-dents per week, of which 32% referred to audio from "less than 10 minutes ago", 26% from "10 minutes up to an hour", while only 6% were from over a day prior. Of the incidents reported, 25% occurred in public, 44% in semi-public spaces (defined as schools, workplaces, etc.) and the remaining 31% in private space (predominantly car and home). In 44% of the incidents, participants indicated that people unrelated to the audio they wished to retrieve (*e.g.*, other customers in a restaurant) had been present during the time they would have liked to record. I collected follow-up information for 83 incidents during the weekly interviews.

Participants asserted that they would not have felt rude towards their communication partner using PAL in 52 of these. During the second and third weeks participants were questioned about their reactions had their partners objected to their use of the application. Participants stated that such an objection would be "not likely" in 24 of 26 incidents queried and indicated that they would not have complied with the objection, had there been one, in 19 of the 26 incidents queried. Only in 4 occasions participants asserted that unrelated bystanders could have been concerned had they known that they were using PAL. When asked how far away they would like PAL to record, 67% chose within a small room (10 feet), 22% preferred smaller areas (own voice or arm-length distance), and only one individual requested a large radius, reporting that he "is just nosy". During interviews, participants reported on how long they would be willing to search for content rated at various levels of problematic. If they were "neutral" (scoring a one on a five point scale) about the content, they reported being willing to spend an average of 336 seconds ($\sigma = 172$) to search, whereas if the audio content was of vital importance (scoring a five), they reported being willing to spend a minimum of 15 minutes with three users responding "however long it takes" to retrieve it. These results indicated, in keeping with Richter's assessment (Richter, 2005) that the more important the content and the higher the need for the information, the more likely people would be to go back and retrieve that content.

3.3 Formative Studies of Capture for Care of Children with Autism

Although many of the features of capture in general everyday activities are also of interest in the particular case of caring for children with autism, many other needs are necessarily unique in this particular domain. To begin to understand these needs both of children with autism and the people who educate and care for them, I conducted multiple formative studies. I describe these studies and their results in this section.

3.3.1 Field studies of caregivers of CWA

Beginning around the same time as the PAL project (late Fall 2002) and again as part of a larger research team, I designed and implemented a formative field study of caregivers of children with autism. Caregivers can be parents, friends and family, teachers, doctors, professional specialists or any other people who regularly interact with and/or provide educational opportunities for children with autism. For parents and other family members, becoming a caregiver of a child with autism is a truly life-changing experience and generally unexpected. The journey may begin with a simple concern that the child, often two or three years old, is not doing something he or she should be doing developmentally or was doing previously and has stopped. From this day forward, these people are caregivers to their children necessarily even as the children become adults, a fact that once realized can be in and of itself overwhelming. Thus, these caregivers often work tirelessly with those others (teachers, doctors, etc.) who *choose* their status as caregivers to determine the best treatments, monitor and diagnose people with autism.

As part of this project to further understand the needs of all of these individuals, I conducted interviews with a variety of stakeholders in the care and treatment of children with autism, including families, therapists, consultants and educators. I used semi-structured interviews and participant observation (Spradley 1980) to identify current practices, needs, and privacy concerns of the stakeholder groups (Hayes *et al.*2004). The data consisted of audio and video recordings and observer notes. Participants included six individuals associated with a local school system, six professional therapists from three different consultancies, four parents of CWA, and three part-time therapists. The interviews lasted between one and two hours and some interactions continued with a subset of the participants by email. The researchers involved conducted 27 therapy sessions with CWA and attended 40 meetings and three training sessions, conservatively totaling 144 hours of participant observation during the period of this study[12].

As a follow on to this initial fieldwork, I conducted a series of one-on-one and group interviews with a variety of stakeholders to the evidence based care (EBC) problem of behavioral assessment of children with special needs. The goal of this study was to understand ways in which technology could help or hinder the practice of EBC through development of new applications for data collection and augmentation of these applications with the ability to capture "rich" media, e.g., audio and video streams and sensor readings. I wanted to understand how the social and logistical processes inherent to these practices affects the current methods of evidence collection and how these might affect adoption of technologies into this space.

Participants in this research were relatively diverse, including professional caregivers from both within and outside of the school settings, informal caregivers (friends and family), adults who had as children themselves been subjects of EBC (some of whom continue to be currently), and what we refer to as bystanders, who are those people who may be subjected in some way or another to recording but who do not actively record or review these artifacts. Due to the goals of obtaining varied feedback brought on by both individual reflection and group discussion as well as the particular concerns of some of the subjects (*e.g.* comfort level with group interactions for some

[12] Our research group has continued to be heavily involved in many of these activities, but they were not analyzed and considered with the same rigor. Thus, I do not include them here.

individuals with disabilities), I used semi-structured interviews, participant observation, artifact collection, and focus groups. I then completed a more focused study using a combination of methods, from January to August 2005, concentrating on uses and concerns of video capture in classroom settings for EBC. Interview participants in this study included four adults with Asperger's syndrome diagnosis four special education professionals, and five bystanders. Focus group participants included:

- fourteen professional caregivers from school systems and consultancies in three counties and two states
- fourteen familial caregivers who were primarily parents but also two siblings and one aunt

The semi-structured interviews varied depending on the individual participant but focused on the costs and benefits of recording video for EBC in classrooms. A secondary focus included how these recordings could be uses as communication tools and the ways in which technology might be used to augment existing community practices.

3.3.2 Stakeholder groups

During these formative studies and throughout my work with the caregiver community, I have identified four primary stakeholder groups in this domain. Membership in each group is well defined but not necessarily mutually exclusive and complete. These stakeholders all incur some level of risk in terms of disclosure of potentially personal information. However, not all of them will benefit directly from capture systems created to support this care, nor will all of them be able to consent to the risk incurred. These groups are:

- *The individual for whom the care is offered*

In many cases, whether in a medical or educational setting, this individual may have little direct influence over the capture or subsequent use of the data captured about him/her. For example, the child in question may be unable to vocalize concerns or to consent. Because the records primarily pertain to these individuals, the largest number and most severe risks are incurred by them.

- *Caregivers who serve as data capturers*

  These individuals currently employ record keeping of some sort (usually with pen and paper) in their care practices. These records will sometimes include details about the care they are providing, primarily as it pertains to diagnostic and monitoring purposes, but the risks can include use of this information for employee evaluations or legal disputes.

- *Caregivers who view, analyze, or otherwise use data*

  These individuals already work as consumers of the data that is currently manually collected by the caregivers of the previous category. They tend to include supervisors, family members, and sometimes, external specialists and consultants. They rarely capture data themselves, although this can overlap in some cases with the data capturers group.

- *Bystanders to the recording of data about care*

  Individuals belonging to this stakeholder group can be but are not necessarily caregivers, family members, nor even acquaintances of the individual for whom the care is offered. They are people who are near to or who interact with individual under care during an incident significant to

> either the diagnosis or the monitoring of the patient/student. For example, if a child with developmental delays approaches a shopper in a store, that interaction, including the shopper's reaction, might be important to understanding the child's particular needs. However, the shopper may otherwise have no other connection to the child.

Through analysis of this data, we have observed many important trade-offs that these stakeholders consider when balancing between the significant human issues and the application of interventions (nutritional or sensory diets, discrete or embedded skills assessment, etc.). There exists a common motivation for reporting data on the everyday activities of the children: to help determine what impact a particular intervention therapy has had or to determine what antecedents exist around behaviors of concern.

3.3.3 Data capture for care of CWA

There is little argument amongst behavior analysts and educators that analyzing data about children with special needs would help design interventions for both educational and behavioral goals. Observing and communicating about progress made by a student or patient through records can be extremely encouraging and motivating to caregivers, as well.

> *"It's also just encouraging, at least for me, to see any improvement… it's just plain encouraging, even if it's not going to change his life that he does X, I love to hear that."*
>
> - mother of a child with special needs

> *A: He can't tell us who his best friend is. He can't tell us whether he ate his lunch. He can't tell us any of those things that other kids come home from school and can tell their parents… so [record keeping] is an essential part of this communication that we wouldn't get otherwise*
>
> *B: And those are the things that we want the parents to see [visually or first hand].*
>
> - mother of a child with special needs, with response from a para-professional in the school

Given these positive potential outcomes from record keeping, particularly when it involves rich evidence, it might seem surprising that we encountered so many situations in which the individual caregivers charged with caring for a child with special needs and recording data about that child either did not capture data at all or did so poorly. The problem, however, is unlikely one of lack of motivation to record so much as inability within the constraints of the caregiving environment.

Teachers are primarily employed to teach, and they rarely take time away from that primary purpose to record data. A county level special education director reported that simultaneous data gathering is a "strain of resources" and that it is too "overwhelming to try to meet all needs" of caring for a particular child. Furthermore, one behavior analyst who worked directly with teachers on behavioral issues noted "data tends to be what people remember." Although unlikely to be malicious in intent, teachers can often make mistakes when recording data about a child, particularly as the time between the occurrence of an incident of note and time to record information about that incident grows. Just as healthy adults rarely discuss their physical condition with physicians unless there exists a set of negative symptoms, anecdotal data in education tends to be negative.

Throughout this work, we have seen tension between the desire for caregivers to witness first-hand behaviors and other symptoms of interest and the need for caregivers and others nearby or involved in the care to maintain some level of autonomy and privacy. Everyone we interviewed throughout these formative studies, however, expressed at least some desire to record and to share rich media including video.

Caregivers introducing the therapeutic interventions we studied kept records of some or all of three distinct types of data:

- Duration: How long was the child engaged in activity X, where activity X can be appropriate (sitting quietly at the table) or inappropriate (screaming loudly in the classroom)?
- Performance: How often is the child correctly responding to request/question Y, where Y might be "Give me the apple." or "Come sit down." Also, how often is the child behaving inappropriately in a specific way (*e.g.*, hitting himself or others). These performance trials can be done in formalized discrete trial settings (*e.g.*, one-to-one with an ABA therapist or with a paraprofessional or special education teacher at a school) or in more the natural environment, such as in the context of a child's everyday activities in an inclusive classroom.
- Narrative: In this case, the caregiver might simply write a few notes or several pages describing the child's behavior as result of a single incident or as a summation after a full therapy session or completed school day.

Interventions for CWA emphasize a cycle of care that revolves around recording data about the patient and providing care based on that data. This cycle existed in some form across all of the interventions we studied. The basic steps that therapists perform are:

- Diagnosis based on observation and/or interview data collection. This data collection may be primarily naturalistic and observational or can occur during clinical settings in which the child is exposed to directions and stimuli methodically to test particular hypotheses.

- Goal setting with various parts of the caregiver network. These goals can sometimes amount to a "contract" with the family or with other caregivers.

- Intervention based on learning and/or behavior modification particular to the child.

- Evaluation of goals being met or not based on data collection from observation and/or interviews. All of the interventions include some notion of accomplishing pre-determined goals whether by "mastering" a skill or by reducing inappropriate behavior.

- Based on this evaluation, the cycle begins again with a new diagnosis.

This cycle of care is extremely important to the way care proceeds in all of the interventions we studied. However, analysts expressed some frustration with occasionally being unable to assess progress towards these goals. In these cases, the hurdle to success was primarily in the data recording and sharing capabilities of those individuals directly interacting with the child.

3.3.4 Social, Practical, and Technical Considerations of Individual Caregivers

In this section, I discuss social, practical, and technical considerations for the design of capture and access systems for supporting capture of information about children with autism (CWA):

- Caregivers need rich data for quality monitoring, analysis, and diagnostic work, but there exists a tension between the need for richer data, including video, and the effort of retrieving and analyzing that data.
- The care of a child is the top priority. There exists a burden however between the long term care goals, some of which require data collection and monitoring, and the more immediate goals of the care situation. Thus, the burden of recording information must be significantly low so as not to interfere with the *immediate* care of the child.
- Concerns about privacy, surveillance and control of data must be sufficiently balanced with social advantages. These advantages can include but are not limited to more informed decision-making, the opportunity to reflect on selves as caregivers and on the larger environment, and the possibility of building trust and a culture of sharing among team members.
- New technologies must be sufficiently inexpensive so as not to add burden to already financially constrained schools and families. Furthermore, this is a constantly changing target, with schools in particular often being given budgets that must be spent during a particular period. Thus, flexibility must be built in to any technologies that things can be purchased piece meal or all

at once. Commitment for some caregivers and schools to buy everything up front may actually be easier than a service or lease model.

- Caregivers have not only significant financial constraints but also considerations about capturing more information than is comfortable for people nor easy to mine. At the same time, access to the types of information required to monitor the particular skill or behavior of interest (*e.g.*, audio only might be appropriate and in fact preferred for a spoken behavior or skill whereas video is required for monitoring when a child throws something). Thus, individuals in a variety of settings must be able to add or remove capture services in an environment depending on the current context of that environment and needs of the care team.
- Capture applications must relate streams of data about any particular event to each other. At the same time, caregivers already burdened can not be expected to make the majority of these connections manually. Some correlations, such as temporal, can be done automatically. For example, we can easily connect and simultaneously replay multiple streams of video within custom viewers. Furthermore, those manual pieces of data that caregivers do attach to an incident can thus be connected to all of the media associated to that incident.
- Caregivers must be able to use the captured data to diagnose particular behaviors, to inform decisions about structuring future interventions, and to provide evidence to concerned parties about the effectiveness of interventions. In some cases, the level of data needed is highly detailed. In others, people do

not necessarily have the time or the need to go into that level of detail, preferring instead overviews of the information. Thus, capture applications must provide access to both appropriate abstracted visualizations and sufficient details.

3.3.5 Examination of the needs of the community of stakeholders

The large quantities of data to be collected and shared amongst researchers and practitioners using evidence based care, particularly for children with autism and other special needs, bring about interesting and unique challenges. Naturally, one of the major considerations is about notions of awareness that evidence is being collected and concerns about privacy, control and surveillance. These concerns involve the collection and sharing of this evidence amongst individuals belonging to each of these stakeholder groups and between the groups. Recognizing the immense challenges of balancing all of these considerations for all of these groups at once, the group and individual interviews that served as the second major formative study of this domain problem focused on the range of technological possibilities for video capture and protection from unwanted capture. When viewed from the perspective of the individual, a cost/benefit analysis often favors the rights of the individual, particularly for those who reap little benefit. In this work, however, I uncovered view points that allow for an argument for the examination of the effects of capture technologies on the community of stakeholders, as opposed to on an individual, for certain domains, most notably healthcare and education, in this case autism.

My analysis, based on this series of focus group and open-ended interviews, reveals three major tensions across stakeholders in addition to those detailed in the previous section when examining caregivers individually:

- Fear of surveillance can interfere with the benefits derived from evidence collection.
- Conflicts exist between a collaborative effort of a network of caregivers and individual autonomy and respect.
- A mismatch can be present between legal and societal norms and direct benefits and practicality.

3.3.5.1 Fear of Surveillance can Interfere with Benefit of Evidence

It is commonly accepted that people don't like to be surveilled, whether by other people or by technology (cameras, etc). The perceptions of others about these attitudes can be as varied as the attitudes themselves. The following exchange between an external consultant and an in-school specialist is a good example of two contrasting sentiments expressed at every focus group:

> *"I also kind of feel like the people who are going to be comfortable being video-taped are the people who are doing what they are supposed to be doing."*
>
> *– Behavioral specialist and consultant*
>
> *"I wouldn't have that reaction at all, being in a classroom setting… I think it is more of a personality thing as far as feeling comfortable… for me its based on the times I was raised in that*

> *being video taped all the time was looked upon as a very scary thing, an invasive thing."*
>
> *–Para- professional, in school caregiver*

Regardless of the reasoning for being uncomfortable with recording, there are two ways in which organizations have tended to reduce concerns about surveillance: providing direct control of it to those who will be surveilled and/or providing visibility and awareness about the surveillance.

3.3.5.1.1 Controlling Data Capture

Providing control of recording to the subjects of that recording can often reduce concerns over surveillance. Current practice in public schools in the United States gives teachers almost complete control of video recording in their classrooms, thereby providing for them protection against unwanted recording for any reason, although this control then of course does not extend to the children in that classroom. If teachers want to record something to show to another teacher, an administrator, or even a parent, they usually can. Occasionally, a parent or an administrator will request evidence of a particular inappropriate behavior or of a new skill. In these cases, the teacher is still often in charge of deciding when the video recording will be made and then turns over the evidence to the requesting party. In a rare case, an individual from within the school system may come and record a teacher's classroom, but in those cases, the teacher is nearly always alerted to the recording substantially beforehand. Once a recording is made and is part of the official educational record, FERPA guidelines indicate that guardians of a particular child have the right to access this information at any point, but the data cannot be accessed by anyone else outside the school system (FERPA, 1974).

From the standpoint of the teachers, this approach has both positive and negative elements. Complete control of recording reduces the concern about recording anything the teacher would not want saved, and potentially more importantly shared. It also, however, increases the task load for recording a video snippet for sharing. One special education teacher we interviewed described how she liked to record skill acquisition to show to parents:

> *"I usually try to record the first time I ask a kid to do something and then again after I know he learned it. That way I can put it in the end of the year report….and parents can* ***see*** *the improvement… But sometimes, I realize after a couple of weeks that I forgot to record it the first time and now it's too late."*

The possibility of missing important recordings was an important concern, repeated with all participants. Handing over the control to a third party observer (either machine or human) can reduce this concern of missing important moments, but it introduces its own difficulties. These challenges can include but are not limited to logistical details such as the resource constraints of observing classrooms all day, the potentially disruptive interactions of an observer with the children, and the potential negative feelings of intrusion by this third party observer.

3.3.5.1.2 Visibility and Awareness over the Lifetime of the Recording

Healthcare and education both have a tradition of surveilling trainees using human experts to document occurrences in a classroom or hospital. In education, this tradition is often instantiated as a practicum course, in which a teacher as part of training is supervised in a classroom by the course professor. This level of visibility reduces some concerns over surveillance, but introduces new difficulties.

> *"…here's the scary thing. We go in to observe, and observation cures. Nothing happens… because we're a novelty and they [children] are curious, even though I never make eye contact with the kids…"*
>
> -behavior specialist, education trainer and professor

Although bringing in a third party observer allows an individual trained in diagnosis and intervention for the particular problem to witness the symptoms first hand, it is also fraught with its own difficulties. One professional caregiver noted "everyone's behavior changes when people come to observe," a particularly large problem when dealing with socially inappropriate behavior. Thus, when attempting to diagnose inappropriate behavior of a student at a public school, the behavior of that student, which may be set off by any combination of other external factors including the behavior of the teacher and of other students, cannot be accurately diagnosed nor monitored when an observer's presence alters those external factors.

Another large issue with using a professional external observer is one of being with the student at all times that the behavior may occur. Caregivers reported that the majority of families find home visits by professionals to be "too invasive" but at the same time will say "If you could just see them at home" when describing particular behaviors. Thus, providing complete visibility of observation may still be considered socially unacceptable. For individuals who are the subject of care, this tension may be particularly acute. The desire to be able to review previous recordings later in life and the desire to receive the best care possible can directly conflict with comfort levels of recording as noted by a 30 year old man with an Asperger's syndrome diagnosis (ASD), to whom I refer as Adam.

As a child, Adam's behavior seemed "odd" to his parents and teachers. He was extremely uncomfortable in large groups of people and expressed terror at the idea of meeting anyone new or traveling to a new place. Academically, Adam excelled, but socially, he was greatly diminished. It was not until Adam was diagnosed as an adult with ASD that things began to improve for him. Armed with information and new coping strategies, he has been able to integrate somewhat into society and attend college, although he still struggles regularly. Adam noted that he wishes "he could see video of [himself] as a kid, so [he] could know what other people were talking about." He also describes himself as "camera shy," however and noted that he would not have liked to know that the camera was on as a child and would have preferred something "hidden up in the ceiling like a security camera… kids should have recording about them even if they don't like it… [caregivers] might need it, and [the children themselves] might want it later." Thus, when designing socially appropriate technologies to support collection of evidence we must consider not only the risks and benefits of the stakeholders currently but how these might change over the course of a lifetime or longer.

3.3.5.2 Tension between Community Work and Autonomy

In each of three group interview sessions, at least one individual expressed the viewpoint that caregivers who did not want to be recorded may not be as competent or at least as confident in their performance as those who did. One individual in a supervisory role even went as far to note that "intermittent .. unpredictable video taping can be one of the greatest protections for non-verbal children," a comment that was quickly followed up by a specialist in the session who noted "people that object either are not confident or *know* they are not doing a good job."

Although these sentiments may appear to be cynical in nature, they exemplify a theme that occurred throughout the study, one of using video to uncover difficulties in both the caregivers and the subjects of care being recorded. A number of concerns of individual caregivers tend to prevent widespread use of capture technologies in educational and care environments. Fear of being reprimanded for mistakes in treatment and instruction is rampant even among caregivers recognized to excel at their jobs. One education specialist commented that "teachers should see themselves on video… 'cause I don't think you have to say a word" for them to learn from the clips, but at the same time, she noted that "they dread it. They hate it. They don't want to see themselves on video. Nobody likes it. You don't realize how many times you blink your eyes or how often you do this [makes an example hand gesture]…" indicating a repulsion to video recording that has little or nothing to do with traditionally considered concerns about privacy. These considerations are echoed throughout the education and social science literature in which video is used as a tool for self-reflection and teaching, as described in Chapter 2.

3.3.5.2.1 Using Recordings to Build Communities

Despite the fears of caregivers, the people most often noted as being potential critics (*e.g.* parents in the school setting almost unanimously reported wanting to support them.

> *"When [my child] was little bitty, he was in a daycare situation that was just getting this web camera put in place… and it never occurred to me that the teachers in the*

daycare felt this was very much an invasion, that we must want this because we didn't trust them, and we were like 'oh gosh, we don't actually want to see you. We just want to see our kids.' … and when I found this out about the daycare teachers, it was like 'Whoa, okay [gestures stop with both hands], it's not worth it to me to make you feel uncomfortable.'

- mother of two children with special needs

Rare malicious individuals aside, all of the potential stakeholders in a system designed to capture information for the care of CWA are likely to have as a goal at some level to provide (or at least not to impede provision of) the best care possible for individuals in need. Recognition of this shared goal, coupled with appropriate use of video can break down these barriers to communication and group problem solving and allow people on all sides of the issue to understand one another's views. A school director pointed out that recording and sharing recordings may in fact be one of the best ways to build a "culture of trust."

"[Recording and sharing of video] goes a long way to create a culture of trust."

- Director of a behavioral education center

"You have to build teams, and I can see this as building teams."

- Behavior specialist at the same center

His plan was to use video recordings to have group discussions and teacher training sessions in addition to using them as diagnostic and monitoring tools. In other sessions, similar sentiments were expressed, with one teacher excitedly commenting “I love trouble shooting with a bunch of minds” and with video, you can share this “better quality of information.”

Concerns about recording can center on how the recordings would be used within an organizational or social structure that can include power differentials. Fear of negative repercussions, whether justified or not, can be enough to convince a caregiver not to use video recording. Within some communities, however, video and evidence could be used as positive trust building communication tools as well as tools for self-reflection. Use of evidence among team members can open new lines of communication and build trust as well as protect those being cared for.

3.3.5.2.2 Protecting Members of the Community who Might Object

Even in communities in which trust is being built and common goals are shared, individual caregivers and bystanders can still lose their senses of autonomy, their freedom to choose whether or not to be recorded, and hence some level of their privacy. When asked about what events in particular should be recorded about a child with ASD, one of the participants, an adult with ASD himself, responded, “all events that take place with other people,” a sentiment echoed by nearly every caregiver we interviewed.

Recording any time a child interacts with another person necessarily requires recording a large array of people, some of whom would be fully sympathetic and others who may not. When designing for this need, we must consider then what the policies of these individuals might be. One potential solution to recording all the time but still providing individuals to opt in or out of the recording is to apply filters to the video, essentially to blur people out, or to avoid recording when individuals who object are present. Particularly of interest is the idea of blurring an individual's face or other identifiable features, thereby ensuring anonymity for that individual. These solutions, however, have serious repercussions for the evidence being collected.

> *"I don't like that. You can't see what that otherchild is doing. If I don't know that… [no diagnosis can be made.]"*
>
> - Behavior specialist after being presented with examples in which most people other than the child of interest are blurred most of the time

Caregivers noted that with children with special needs, particularly social disorders, observations of the larger context of and the other actors in the environment are a necessity. Without being able to see these other bystanders and their behaviors, it is impossible to make an accurate diagnosis. Thus, a piece of video blurred to protect the privacy and anonymity of the other people nearby would be useless to those practicing EBC in this domain.

When presented with the idea of selective archiving[13], however, the response was overwhelmingly positive. Parents noted that this type of control would give them an option to record a behavior of particular concern and send it to a specialist without having that specialist in their homes to observe. They also noted that being able to share identical copies of recordings of interesting incidents might encourage caregivers to work together. Teachers noted that they would be able to ask specialists questions about behaviors and

[13] The technical details of selective archiving are outlined in Chapter 3. As a reminder from the Introduction, however, selective archiving is concept that a set of capture services are always on and available but do not archive without explicit intervention.

about their own responses, again without requiring the costly endeavor of an on-site evaluation. They also expressed that with selective archiving they could use their own discretion to choose when and when not to record, giving them a sense of being in charge of the video recordings but without the fear of missing important moments as discussed in the previous section. Specialists commented that they appreciate not having to look through hours of video to find the incidents of note. They also expressed that they sometimes need the context of interactions that may be hours or even days before an incident to diagnose a particularly complex problem.

> *"My immediate reaction [to the idea of selective archiving] is 'oh that's kind of neat' because we don't know when the behavior might occur, but 'oh gosh it just happened' and now we can go back and see what happened twenty minutes previously to see if there are any triggers we missed. .. I would be more willing to [look through the video] because I* ***know*** *something happened."*
>
> \- Lead behavior specialist

They commented that giving teachers too much control might result in some of the same problems with recording as they witness currently, but that selective archiving was a compromise with which they were willing to work. They would be able to witness incidents free from teacher interpretation or analyze the data coupled with teacher commentary depending on the needs of the given situation.

3.3.5.3 The Effects of Legal and Societal Norms Paired with Benefits and Practicality

Parents of children with special needs in the United States are sometimes asked to consent to recording pictures and video of their children at the beginning of each year. Parents of neuro-typical children, however, are rarely asked for the same level of consent. In hospitals, private clinics, and special housing institutions for physical and mental health, again the caregivers and patients are often asked to consent to recording. Significantly, those recordings are then covered under laws designed to protect medically sensitive data. Visitors to these institutions, however, who are neither patients nor employees, are unlikely to be given the opportunity to consent to recording. Because caregivers have so rarely asked for such permission, we can only hypothesize as to the reactions based on their prospective considerations and philosophical arguments.

> *"From a school's standpoint, it always comes back to a confidentiality issue… they have security cameras on that [record] all the time, so I don't know if [it could become] kind of a standard, you're on camera whenever you're in a school building."*
>
> \- Special education director at a public school

Societal norms and standards with regard to recording in public institutions are moving targets. Even now, in Europe, the CCTV initiatives (Norris, *et al.*, 2004; Smith 2004; Walby 2005) demonstrate that communities will accept large scale ubiquitous recording if they believe the recording will be used for safety and emergency purposes and only those purposes. For these particular concerns, the collective community is generally considered to be more important than an individual's concerns about surveillance, privacy, or consent. Similarly, health and education records, usually protected, are often shared during times of crisis or in situations when the health or safety of a large group of people is in jeopardy (*e.g.*, during a disease epidemic).

Practical difficulties and logistic hurdles make getting the consent of every individual to share this personally identifiable information in these situations a nearly impossible task. Furthermore, practically speaking it may be excessive. The records of children with autism are usually protected under the Family Educational Rights and Privacy Act (FERPA, 1974) and the Health Insurance Portability and Accountability Act (HIPAA, 1996) in the United States. Similar laws exist in other countries, but for the purposes of this dissertation, I discuss primarily the implications of FERPA and HIPAA on EBC. These laws would protect the personally identifiable information not only of the primary individual receiving care but also of any bystanders or caregivers present in the recordings. Under FERPA rulings, parents or eligible students can review any records stored for the student at any time and can then request updates to any records believed to be inaccurate. Schools must also have written permission from the parent or student to release any information from a student's education record, with some notable exceptions, such as to other school officials, to organizations who are conducting studies on behalf of the school, to legal entities or in conjunction with health and safety emergencies. Many school officials expressed concerns about including rich media in the official student record primarily for fear of needing to release the records to these parties, as in a lawsuit or other contentious situation.

> *"[In a school] you can't even take a still photo of a child without parental consent… you're not supposed to do it even if its not going to be published… you're not supposed to do it even if it's just going to be published in a school newsletter."*
>
> - Para-professional from a public school

This quote exemplifies the challenges encountered by school officials imposed primarily by the current social and legal climate. As these norms change over time, so will the confidentiality concerns in these settings.

3.3.6 Balancing Considerations

The human constraints imposed by the cycle of caring for CWA and the concerns about capture in unstructured and unpredictable situations influence and are influenced by the technical considerations inherent to ubiquitous computing and capture and access applications. Applications must balance needs such as ease of use with an architectural separation of concerns. Most of the caregivers with whom we interacted indicated that recording of rich data would be valuable and worth the cost (financial and social) if they had greater awareness and understanding of the technologies, could use them with ease and without pre-planning, and could control the capture and distribution of data.

By evaluating not only personal risk and reward models for potentially invasive technologies but also by analyzing risk and reward for the larger community of stakeholders, we can design more appropriate solutions for a set of domain problems that are particularly important to groups of individuals. These problems are prevalent in education and healthcare. In particular, the analysis of stakeholders in data capture surrounding the care of CWA uncovered three significant points of tension for four disparate stakeholder groups in addition to those uncovered when examining the individual risks and rewards of the caregivers. An appropriate design that both satisfies the requirements of collecting much needed evidence and addresses these tensions was then developed from this analysis.

In Chapter 4, I present in detail one technical solution for balancing the risk and rewards inherent to this domain problem. That solution must sit within a human framework of responsibility that allows for appropriate use of audio and video capture coupled with protections against abuse. In the case of using capture for diagnosis and monitoring of children with special needs, there is usually one adult caregiver who serves as the primary data capturer in any particular environment at a particular time. This adult is most often a parent in the home or a teacher in the classroom. The model of evidence collection that employs selective archiving of captured video allows for a balance of the benefits of use of video in EBC with the tensions and challenges uncovered through our stakeholder analysis. This primary caregiver can act as a real-time negotiator of privacy policies for a variety of stakeholders. For example, she can verbally request consent from a bystander who interacts with the child for a period of time or she can determine at that time that consent would be unrealistic and potentially unnecessary. She can also make decisions for members of the community who are unable to consent because they cannot make those decisions or they cannot verbalize that choice (*e.g.,* other children in a classroom or friends or siblings in a home).

Although acting as a real-time negotiator of privacy policies can be an added burden to this caregiver, reduction in the data recording requirements (*e.g.* by moving from manual to automatic recording) significantly offsets this added burden.

Furthermore, these caregivers are primarily in similar situations on a day-to-day basis from which they can develop patterns of use (or avoidance) of recording. Using this model, we can reduce the visibility of the recording for the majority of participants, because the caregiver and primary data capturer will be aware of the recording. In fact, this caregiver will be controlling archiving of anything that was recorded.

Reducing the visibility is important in when collecting data about children with special needs, because it can disrupt the environment less and thus increase the quality of the evidence being collected. When presented with the selective archiving model, all of the caregivers and EBC subjects we interviewed recognized that there were still issues to be considered, but at the same time, they were unanimously positive. One school official commented on both the ease of use of a selective archiving solution and the reduction of privacy and confidentiality concerns: “I think anyone [could do it], and I don’t think you’d have any problems with confidentiality or anything [because] the teacher controls it.” Bystanders were most positive in response to models that either did not record identifiable information about them at all or recorded it in such a way that they remained anonymous (*e.g.,* blurring).

When presented with information about the relative utility of such models opposed to a constant recording or a selective archiving model, however, all but one conceded that they would accept the selective archiving model if approached by a human data capturer, such as a caregiver. An open question in designing for EBC, then, is how to alert bystanders to the presence of recording. In the particular case of caring for children with special needs, caregivers are most likely to want to archive video snippets involving bystanders when the child has interacted with the bystander. Thus, some level of entrée has already been established allowing a primary caregiver to approach this individual with a verbal request. In other scenarios, one could easily implement notification events such as lights or sounds to indicate the saving of a recording, and couple these indicators with other notifications posted in an environment about the potential for recording.

By using simple signals to indicate when rich data, like video or audio, should be recorded, capture and access applications can help users gather all of the data needed and navigate this potentially enormous sea of data without the significant social and technical concerns inherent to capture applications. Thus, in the work described in the majority of this dissertation, I use an approach in which end users can choose from available buffer services to assist them in easily controlling capture without having to pre-plan. I also attempt to provide appropriate affordances and application interfaces to these services to address providing awareness and understanding to users and to help satisfy the constraints specific to each situation.

3.4 The General Natural Environment Capture Problem

This chapter includes descriptions of a set of formative studies, of varying lengths and complexities focused on a variety of human problems. Fundamentally, however, they are all aimed at understanding the ways in which people currently take notes and document happenings in unstructured and potentially informal, everyday settings. When examined simultaneously, these studies begin to bring into focus the design space inherent to the more general natural environment capture problem. I perceive three major axes to this space:

- Need or desire to have the information recorded
- Burden of capturing or accessing that data

- Physicality, awareness and understandability of the phenomena and setting as well as of the capture system itself

There are, of course, wide varieties of ways in which this design space can be laid out and partitioned. For the purposes of this examination, however, these four features are appropriate for a framework of discussion.

3.4.1 Need or desire

People often make choices about the effort they will undergo and the risks they will undertake in consideration of the potential reward. Other factors, such as personal preferences and aversions, certainly come into play as well. Fundamentally, however, for any data management technique to succeed, whether technology augmented or not, there must exist some need for the information being gathered.

Fitting into the need or desire for data is the quality of that data. Not only must a person want access to information from an experience, but that data, whether video, text or other types of media, must be sufficient of sufficient quality for constructing an appropriate account of what occurred for use. Furthermore, improved quality of data is also likely to increase its desirability as well as the willingness to do the capturing in the first place.

In the case of caring for children with autism, a wide spectrum of belief in data collection exists. Some caregivers, such as most applied behavior analysts, live and die by the data they collect. Others, like some professionals and some parents, take a more relaxed approach to data collection, relying more on the gestalt of the child's progress than on quantitative metrics. Both strategies, and everywhere in between, certainly have their places in the care of these children, and all include some level of documentation and monitoring of progress. This focus on monitoring of progress may be due to an emphasis on outcomes-based education and individual education plans or the particular training that special educators and behavior specialists receive or some combination of other factors. Fundamentally, however, this domain problem represents a relatively high need of capture with motivated persons in support of a group goal.

In the case of more informal capture, such as that resulting from unplanned small group meetings, casual interactions, or personal notes, there is likely less of a need or desire for the recorded information. In these settings, people rarely go to the trouble to document things on paper now, often relying on memory even when they recognize the potential faults of this strategy. Those short informal notes that are taken, even when perceived to be important at the time of capture, are often ignored or lost later on and therefore not accessed. Thus, as a contrasting domain problem, more general informal notes demonstrate a lower need of capture with individuals who may or may not share a group goal of some sort.

3.4.2 Burden

The burden of recording and making use of data becomes a factor at both the time of capture and the time of access of that information. During event itself, people often want and need to remain engrossed in the activity at hand. Truong lays out characteristics of capture and access applications that attempt to unburden the human participant in the capture (Truong, 2005).

One of these characteristics is that capture should happen naturally. In many full automated capture systems, this requirement is easily met. Using the structure inherent to the setting and automatic services that record all the time, a person can simply rely on this capture. In more naturalistic settings, whether as part of the generalized note taking problem or specific to care situations, however, one simply can not rely on structure nor fully automated capture all the time. Thus, I expand the notion of naturally to include practices that can be incorporated naturally into the activities at hand. Thus, buffering capture streams unburdens users from starting the capture, and they must only actuate archiving or deleting at some time in near proximity to the event of interest. Furthermore, I have worked to provide straightforward and simple interfaces to those activities, such as single buttons whether physical or on a software application.

Another noted characteristic is that information should be accessible with minimal effort. This characteristic is fundamental to the work that I present. One of the motivating factors, in addition to the social and legal concerns, for not capturing all the time in everyday life to ensure the capture of those few moments of note, is that this model would produce a multitude of useless and/or inaccessible data. Storage is cheap and it may one day be possible to efficiently mine an enormous quantity of audio and video data automatically, but current limitations indicate that easing the burden of access at least in part means minimizing the amount of data such that only what is needed is what is captured.

3.4.3 Physicality, awareness, and understandability

Like any computing system, the physicality, affordances, and even aesthetic inherent to capture systems influence not only how they are perceived but also how they are adopted and used. When considering the natural environment capture problem, these issues can become even more significant.

An appropriate balance of obviousness both that services are available and that recording is taking place with disruption to the environment pre-capture services must be achieved. Notions of invisibility have become commonplace in Ubiquitous Computing, often described as the ultimate end goal for truly "calm" and ubiquitous technologies. One question I believe remains to be answered then is how truly invisible we are prepared for our technologies to become. For example, we have had the ability for years to turn lights on and off automatically on a schedule or based on movement. Surely use of these technologies could reduce our energy costs, eliminating the problem of leaving the lights on accidentally. Security and convenience are two other potential benefits of such systems. Despite these benefits, however, these systems are not in particularly wide scale use, and particularly are not often used in homes. Furthermore, even in those places that do use such systems, there is nearly always a manual override (*e.g.* a light switch). Given the relatively risk free technology of lighting, is it hard to imagine that complete invisibility is not necessarily the appropriate end goal for the relatively risk capture technologies?

In this work, I explore a variety of notification mechanisms and physical designs for the capture technologies designed for unplanned experiences. These different designs within different domains shed light on the ways in which notifications, awareness, and understanding of these technologies affect their uses and perceptions about them. For example, when caring for children with autism, it is important to minimize child awareness of these technologies in the event that their behaviors might be altered by this awareness. Caregivers, however, may choose to be reminded more frequently of capture.

Again, as a contrasting setting to the care situation, general informal note taking usually involves primarily people who are prepared to and wish to make their own decisions about capture and arguably to be aware fully of those activities. Thus, I explored the ways in which notification mechanisms and demarcations about capture surrounding a mostly visible system would influence perceptions about it and about the space it inhabited.

3.5 Summary

In this chapter, I describe my initial interest and motivation in the concepts of information note-taking and unstructured, unplanned capture experiences. Base on this interest, I undertook a simple survey study to examine some of the problems of this type of note-taking in the natural environment. I describe two studies that began at nearly the same time: formative explorations of a personal audio-based memory aid and in depth field studies of the needs of caregivers of children with autism. By working on these two projects at the same time, I began to see how many of the tensions and concerns raised in the evidence-based care situation could be addressed using a more generalized concept of the "loop" provided in the personal audio loop. This concept, selective archiving, thus flowed naturally from these formative studies and is described in detail in the following chapter.

CHAPTER 4

PROTOTYPE IMPLEMENTATIONS OF SELECTIVE ARCHIVING

As a way to balance the social, technical, and practical concerns of capture applications described in Chapter Three, I developed the concept of *selective archiving.* The idea behind selective archiving is to provide mechanisms for capture that do not require users to pre-determine when they might want to record yet also do not result in the generation of large quantities of unusable or irrelevant data.

In this chapter, I describe the prototype implementations used to probe and test the concepts of selective archiving. First, I describe the experience buffers, a prototype implementation of the concept of selective archiving. There were multiple versions of the experience buffers architecture (EBA) developed over the last few years for different prototype applications. They are different only in small implementation details. Thus, I describe the EB architecture as it was used in the primary application of interest, CareLog. This Chapter also includes descriptions of the implementations of both CareLog and BufferWare and provide some insights into the design process that brought them into being that are not outlined elsewhere.

4.1 Experience Buffers Architecture

The Experience Buffers Architecture (EBA) includes a collection of capture services embedded in an environment that do not archive information in and of themselves (Hayes *et al.*2005). Rather, experience buffers save information for a certain period of time set by the users of the system. During the time period that the information is saved in the buffer, applications can use short range RF to wirelessly request some subset of the buffer's data. After this time has passed, the information disappears. In this way, users of mobile applications can take advantage of environmental capture services if and only if they are present in that environment at the time that the information is captured. They can retrospectively choose to archive a piece of information thereby leveraging the computer's ability to capture information not pre-determined to be of importance and the human's ability to notice that a salient moment has occurred. Currently implemented buffer services include collections of still photographs, video streams, audio streams, and inking. Future data that might be buffered would include sensor network data.

EBA was implemented using a collection of custom-built C++ and Java objects, the JNI API and sockets for communications between these objects, and a freeware video encoding object[14].

4.1.1 Video Capture System

The Video Capture system includes all of the code for capturing, buffering, assembling, deleting, and archiving video segments.

The encode object performs the task of compressing the one second AVI video segments saved from each camera into the mpeg file format. This portion of the system is implemented in C++ to utilize the performance gains inherent to the mp3 encoding component as opposed to a virtual machine such as Java. The capture object interfaces with the Java objects through the use of the JNI API.

[14] BeSweet is an audio transcoding tool that allows for the conversion of audio files from one format to another. Supported formats: MP3, AC3, WAV, MP2, AVI, Aiff, VOB, Ogg Vorbis. It can be downloaded at http://dspguru.doom9.net/

The video buffer module saves the video from each “web cam” (all instances of camera.java) and the audio from one microphone (all instances of mic.java). It then combines the audio streams with each video stream into individual AVI files named using the ID specified by the Video Server Coordinator. This file is then passed to the capture C++ object for encoding to the mpeg format. When a request for a video segment is received by the VideoBufferServer class, concatenation of the requested clips is triggered. The video stitcher gathers the relevant video snippets for the requested time period then stitches them together into one file. Upon completion, the requested file is transferred to the central machine (or the particular folder on the capturing machine that has been designated) and its pointer is entered into the application’s database.

Finally, the video server coordinator uses temporally derived ID’s to synchronize video segments between the various video servers in the environment. In addition, it manages signaling the relevant video servers to delete obsolete video segments and remembers which segments are currently available. Remembering what is available is important when requests are received for future clips (thereby pausing the process until all of the segments become available) or for past clips that have already been deleted (thereby initiating a process by which as much of the requested material as is available is stitched into the final segment).

4.1.2 Applications Interfaces to EBA

Applications can access EBA services through simple network socket commands. Each instantiation of the buffer service creates a listening socket and communicates with a primary buffer handler. In the case in which only one service machine is available (as is the case in the BufferWare installation), that one machine serves as the buffer coordinator. The coordinator uses sockets to communicate with the other services as well as with any applications making requests for media to be saved.

If all of the requested media is available, each experience buffer stitches together the available media into one file and stores it. Depending on the particular implementation of that buffer, the file may be stored locally or on a networked drive. In either case, a unique URL is returned to the requesting application. Those applications can simply store the URL and access the media at its original storage location or download the media and store it on its own application server.

If some of the requested media is available, but not all of it, two situations can result depending on the reason for the media's unavailability. If the media will become available (the application has requested some media that has not yet been recorded), each buffer will wait until the time that the media is available and then stitch as in the first case. If the media is not available because it has already been deleted from the buffer, then however much is available will be stitched together, and the unique URL is returned in the same manner as the case for which all requested media is available.

If no media is available for the time period requested and it will never be available (it all occurred in the past and has already been deleted), each individual experience buffer will return a null to the program resulting in a caught and logged error message. That message is not, however, propagated along the socket back to the requesting application. Instead, EBA closes the socket without sending any information back to the requesting party. In the case of the experimental applications used as part of this dissertation, the application then produces an error message. This message is the same whether the network is dropped or EBA closes the socket based on no data and could be considered a known bug for certain types of mobile applications that may have variable network connectivity.

Table 1: Socket API to EBA coordinator and servers. Some of these commands were never used in CareLog nor in BufferWare but are included as part of the architecture and have been used in other applications.

Command	Parameters	Usage
~		test for an open connection
MONITOR		Opens a persistent socket for passing information about what's going on in the system
"GET_DATA",	Clienttime Starttime Stoptime the IP you're sending to (to deal with routing issues)	makes the archiving request returns the archived file name
"GET_DATA_FILENAME"	Clienttime Starttime Stoptime the IP you're sending to (to deal with routing issues) Filename	makes the archiving request
DELETE_FILE	Filename	delete an archived file filename
DELETE_BUFFER		delete the entire buffer
GET	Prop	returns a property value from all available video servers when making a property value request returns property values from each of the video servers
GET_FROM	machine prop	get a property value from a particular video server returns property value from the specified machine
SET	Prop value	set a property value for all available video servers
SET_AT	machine prop value	set a property value for a specific video server

SET_DEVICE_AT	machine device prop value	set a property value for a specific buffer on a specific video server
STOP_CAPTURE		Tells all video servers to tell their media buffers to stop buffering
START_CAPTURE		tells all video servers to tell their media buffers to start buffering
SHUTDOWN		stops capture at all media buffers for all video servers then shuts the coordinator down
SAVE_FILE	Filename File data	saves a particular file
UPLOAD	Filename File data	sends a particular file to the location of the user making the request

4.2 CareLog

CareLog is a prototype system for supporting Functional Behavior Assessment (FBA)[15] in schools. CareLog supports the capture of audio and video data surrounding behavioral incidents using the experience buffers architecture. CareLog also supports the current practices of hypothesis testing and data analysis inherent to FBA. The experimental set-up used in the study described in Chapter 5 included four camera angles and one audio stream and could be activated using a desktop interface or using a small remote actuator. The details of the hardware and software set up for this deployment are described in this section.

[15] FBA is a best practice for behavioral assessment for children with severe behavior disorder. This practice is used in schools, homes, and private practices and is described in detail in Chapter Two.

4.2.1 Design of CareLog

I extended CareLog to take advantage of the experience buffers in an instrumented environment with the CareLog prototype. I also exchanged the PDA-based interface used in the initial technology probes of CareLog with a single button to ease quick mobile data collection. When a caregiver presses the button to note an incident, the date and time are logged automatically and a wireless inquiry to the environment is made requesting information from buffer services. When configuring CareLog for use during a particular assessment period, users are asked how frequently an incident generally occurs. By default, CareLog then suggests some time amounts for saving that might be appropriate given that level of frequency. For example, if a behavior is observed twice an hour, CareLog will suggest saving ten minutes prior to the button press and five minutes post. These values are configurable, however, and users can choose either to use a single button press to indicate saving prior to and after the press or to use two buttons, with one indicating a start time for recording (and possibly saving some data captured prior to that point) and an end time for recording (and possibly saving some data captured after that point). Each experience buffer then archives the data requested (*e.g.*, stitches together the last five minutes of video and saves it as a single file), posts it to a secure server and returns a unique URL to CareLog. That URL is then stored in the child's database associated with all of the other information for that incident.

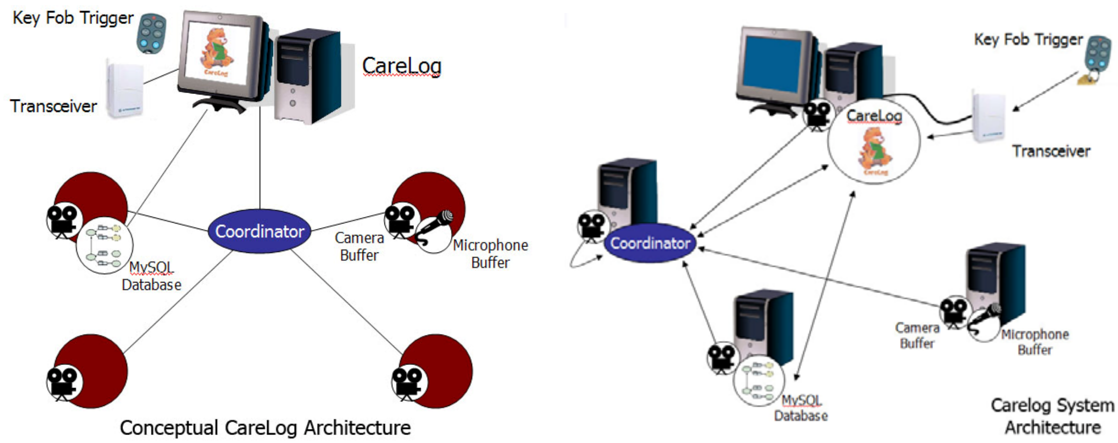

Figure 1: Conceptual and physical architectures for CareLog.

The redesign of CareLog considers not only the lessons learned from experience with the original CareLog prototype and natural environment capture but also the specific access considerations for Functional Behavior Assessments (FBA). Although caregivers mentioned some of the details of the process of performing an FBA during the ethnographic study and subsequent interactions, more information was required for a focused design. Thus, I used paper prototypes to perform a cooperative evaluation with three caregivers, one a part-time therapist and the other two full time behavior professionals. During this evaluation, I and two undergraduate research assistants asked them to mark on the paper prototypes as we discussed the functionality we might provide. Two of the participants even flipped the papers over at various points and began drawing their own interfaces. I used these comments to finalize the designs I chose for the set up and access interfaces. Figure 2 shows an example of comments from the cooperative design sessions. The paper prototyping sessions used a mix of high and low fidelity prototypes. The high fidelity prototypes were included after I experienced difficulty in focusing the discussions on FBA software (as opposed to larger FBA and behavior management considerations) during the first session with an expert.

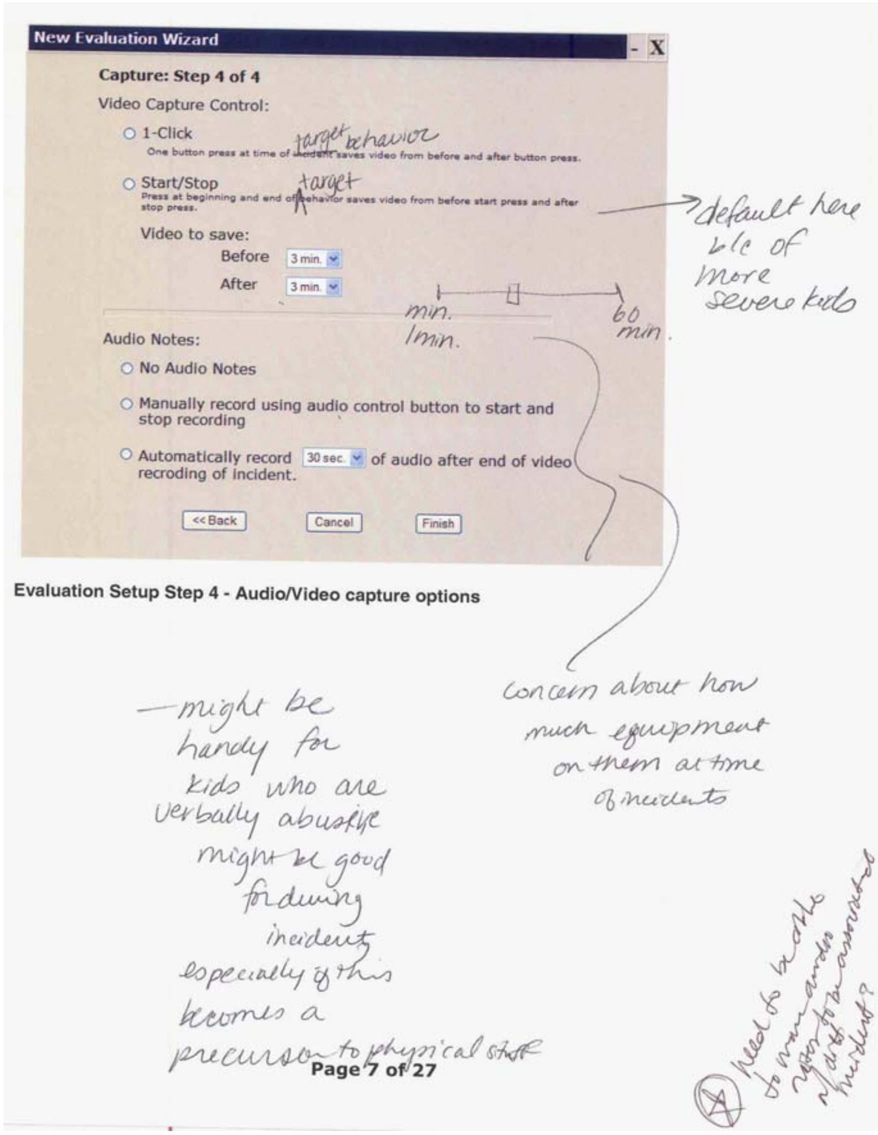

Figure 2: Example of a paper prototype screen after a cooperative evaluation session. The participant noted simple changes, such as the particular wording used, and more complex comments about who might use the system and what sort of functionality they would want.

Using the results of the formative studies described in Chapter Three as well as the design sessions with experts, I developed five key design principles specific to the creation of a system to support FBA in schools. In this section, I describe those principles and the ways in which CareLog addressed them.

4.2.1.1 Blink and you might miss it

Conducting FBA requires the collection of data regarding a large number of behavioral incidents (usually 30 to 50) as well as the context surrounding, antecedents to, and consequences of these incidents. At the same time, students may demonstrate these behaviors at unpredictable times, possibly only for a moment, and sometimes with severe enough consequences that distraction and focus of the staff elsewhere is highly likely. Thus, the teachers and staff members attempting to understand these complex events often miss the details they need to understand the behaviors. Thus, we needed to supply teachers with the ability to gather these details in a fairly automatic way.

The most promising feature of automated capture technologies, and of selective archiving, is their ability to offload some of the burden of notation from the users whose primary activities require their full attention. For example, teachers who may be restraining a violent child or chasing a student who is running away from school can not take careful data in the moment. However, detailed information is essential in these instances for appropriate care. Thus, CareLog uses minimal interfaces to selective archiving to support gathering this data with minimal interference.

4.2.1.2 Power to the people

Despite their potential benefits, particularly in situations in which the primary task is significantly challenging, as in the school setting, capture technologies bring with them significant concerns about control of data, recordation of too much information that is then hard to mine, and other socio-technical tensions (Hayes and Abowd, 2006).. Teachers expressed repeatedly the desire to control recording of data along with other aspects of their classroom activities, such as their behavior management plans and curriculum development. Thus, I sought a solution that would allow for teacher control of data archival and access while simultaneously offloading the burden of beginning those recordings at the appropriate time to capture the right information.

Use of selective archiving in CareLog offloads a significant portion of the burden of capture while maintaining teacher autonomy. Furthermore, there is an additional safeguard of allowing teachers to delete any data that was erroneously saved using selective archiving when they are reviewing their saved information.

4.2.1.3 Keep it simple, really simple

If teachers are to be in control of data capture, they must be able to do so in an incredibly simple and straightforward manner that blends almost seamlessly into their standard daily activities. The primary task of a teacher or a teacher's aid is, and must be, teaching and caring for the students in the classroom. Although data capture is already a part of those care activities, classroom staff almost never let data capture, which is primarily beneficial in the long term, interfere with direct educational and care activities, which are more beneficial in the short term. To accommodate this need, CareLog provides teachers with a simple remote interface (see Figure 3), through which a single button press can actuate archiving of data that documents both what occurred in the past and what is to occur in the future. The exact amounts of time to be recorded are set by the classroom staff using a wizard interface that can be reconfigured at any time.

Figure 3: A teacher holds the remote actuator. Each button can be programmed separately, but all participants chose to have all four work identically: either actuate archiving for a set time in the past and future (e.g., five minutes before button press and five after for a total ten minute clip) or actuate a start of recording plus some time in the past, and then on the second press, a stop of recording plus some time in the future.

Similarly, the tagging and analysis interfaces needed to be simple. To this end, I provided automatically synchronized video feeds and pre-populated but editable lists of appropriate tags. Because classroom staff have very little time to spend analyzing data before completing their assessments, CareLog also provides automatic graphing capabilities to support quick evaluations. In current practice, behaviorists and teachers both reported that teachers sometimes continue to collect data indefinitely because they never have enough time to pause data collection and assess their data to determine whether further collection is even necessary.

4.2.1.4 Temporally and physically shift the burden

During this study, I further unpacked the common complaint by classroom staff that they lack the time to conduct the data assessment portion of FBA: many teachers do in fact have both the time and the interest to do this work, just not while children and other classroom staff members are present. They spend time teaching, managing behavior of students, and managing personnel. The staff they manage can include both permanent staff, such as aides, and itinerant staff (*e.g.*, speech therapists). With all of this activity, they are lucky to be able to record the data, much less analyze it in depth.

Thus, a primary goal of the CareLog design was to allow teachers to access their data at a time and in a place appropriate for their needs. Using a system in which video is quickly and easily captured for later analysis supports some aspects of this need. We noticed in the first few weeks of our deployment of the technology, however, that the notion of mobility needed to be added to the design. Teachers requested the ability to use the system in a location that was more comfortable and quieter than their classrooms. Furthermore, they had difficulty finding time to watch the videos when people who should not have access to the data were not present. Thus, I helped teachers to synchronize the data on a laptop with the classroom system. In this way, they were able to take the data home with them or to another quiet location at which inappropriate individuals were rarely present.

4.2.1.5 Minimize environmental impact

The physicality of a classroom environment can be fundamental to the larger concept of an instructional environment. Teachers carefully plan the physical layout and decorations. In special education classrooms, this requirement can be even more significant. For example, all of the teachers with whom we interacted used physical space barriers, such as masking tape on the floor (see Figure 4), to denote for students the proper placements of their desks. Any changes to this environment can damage the carefully constructed routines that teachers impart on their classrooms. Deviations may also be extremely distracting to the students. In particular, in the case of autism, children might react in extreme ways to any new unknown stimulus.

Figure 4: Two views from overhead of one classroom. Masking tape on the floor of this room denotes where desks are to be located as well as where students are expected to stand when lining up to leave the classroom. This latter use encourages appropriate spacing between students, thereby diminishing opportunities for inappropriate physical behavior.

In designing the hardware and installation plans for CareLog, we paid particular attention to keeping the classrooms as close to their original state as possible. The installation includes four small web cams installed in ceiling area near the four corners of the classroom (see Figure 5). A small pen microphone is installed in the ceiling near the center of the room. Finally, the desktop PC's required to run the system as well as networking and sensor equipment can all be stacked on top of a bookcase along one wall of each room. This installation plan both minimizes distractions and reduces the likelihood that students can reach and damage the equipment.

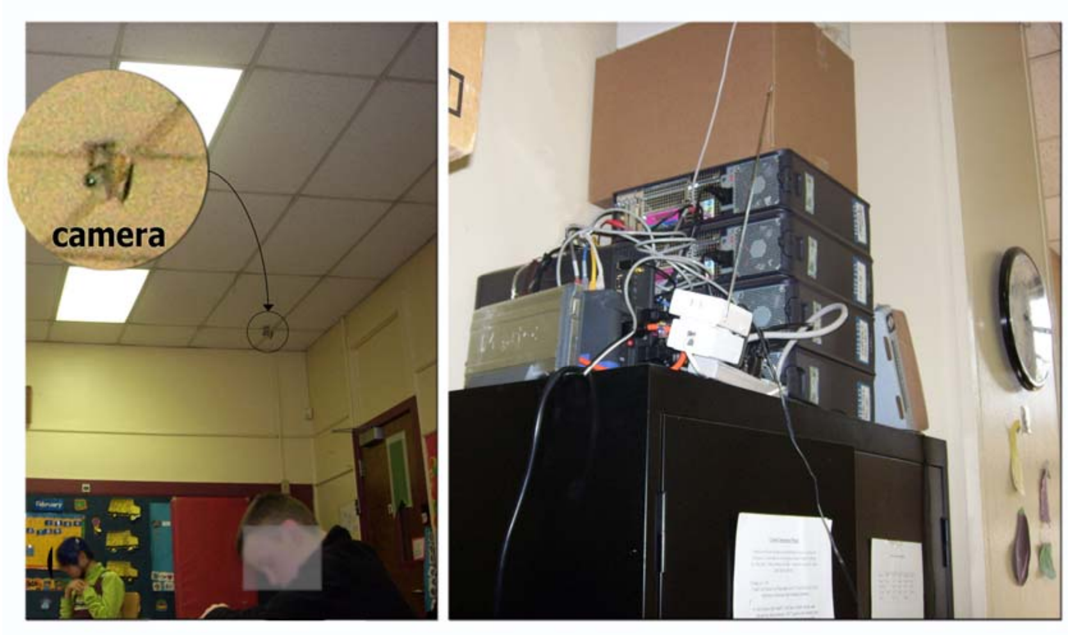

Figure 5: The hardware as installed in one classroom during the study described in Chapter 5.
(left) One of the four cameras in a classroom is attached to the ceiling unobtrusively.
(right) Our computers were stacked on top of tall filing cabinets in each room in the middle of other equipment and boxes typically stored there.

4.2.2 CareLog Hardware

Four camera angles were accomplished by using four individual cameras each attached to an individual desktop PC with the EBA service software installed. I then chose to spread the other responsibilities of running the entire CareLog system across the four machines required to run the video capture portion of the system. Thus, each of the four machines is not only a video buffer server but also maintains other responsibilities within the system as detailed in Table 2.

Table 2: Additional responsibilities of the four video buffer machines in the CareLog setup

Desktop PC	Services and Responsibilities
CareLog1	Desktop application X10 connectivity Backup
CareLog2	Database
CareLog3	Microphone buffer
CareLog4	Buffer Coordinator

To actuate saving data, teachers could either click a button on the desktop interface to save something or use an X10 key fob.

Three pieces of hardware built for X-10 Home Automation Systems were used in the classroom installations of CareLog (see Figure 6). These include:

- A *Leviton Keychain Remote* is used as the remote actuator of archiving. This remote includes 4 programmable buttons, and is approximately the size of a key or automobile remote. The remote could be worn and/or carried by the teacher conducting the FBA.
- A *CM11A module* is used to connect the receiving PC to the X10 system. This module was plugged into the same electronic circuit as the Transceiver Module.
- A *Powerhouse Transceiver Module* to receive the events emitted by the keychain remote. This module must be plugged in to the same electronic circuit as the Power Line Interface. In our case, we simply plugged them together.

(a) (b) (c)

Figure 6: X10 Hardware required for the installation of CareLog
(a) Teachers use a small key fob sized remote device to actuate the archiving of video. All four buttons performed the same action for these teachers, but CareLog allowed them to configure the buttons to each do different things.
(b) The CM11A module plugs into the power supply and is connected to the PC via serial cable.
(c) The transceiver receives the signal from the key fob. We attached the transceiver directly to the power source that talks to the PC through the serial cable depicted in b.

4.2.3 CareLog Software

CareLog contains four distinct interfaces: set-up and configuration, capture, viewing and tagging, and analysis. These interfaces and their implementations are described in this section. All code, unless specified, was implemented in Java, and all interfaces use the Swing toolkit.

4.2.3.1 Set-Up and Configuration

The set-up and configuration interfaces are likely to be used by a behavior professional assisting a teacher or other caregiver in beginning the FBA process. In the experimental deployment of the technology described in Chapter 5, I assisted the teachers directly with setup the first time and encouraged them to make any changes to the set up themselves in the future. Through the simple wizard interface, users can set up an individual evaluation including the details of the child's name, the behavior being monitored, etc.

The wizard also requests such information as frequency of exhibition of the target behavior. Using this information, CareLog can then pre-determine likely values for how long before and after a button press the user would like to save. Users can manually configure these values, but the choices defaulted through heuristics may provide some guidance for new users.

Table 3: Data fields stored in the config file and object.

Field Name	Description	Example Value
Source1 …. SourceN	Source of media for the room in which the FBA is taking place. Each source should have three values to it separated by commas. These are Name, IP, and DataType. The config file can have none to many of these sources; each will be names Source and then a number	localhost
button1ID … button6ID	Each button on the X10 key fob can be programmed by the user for one of three values: -- duration usage -- frequency usage -- nothing	-1
databaseAddress	The IP address or server name of the database server currently being used; for connection string	Carelog2
databaseName	Name of the database on the server being used; for connection string	CareLog
databasePassword	Password to be used on the database	eb
serialPort	The serial port to which the X10 listener is connected	COM2

Configuration information is stored in three places: the CareLog database, a config file, and the config object. The database holds configuration information for each child's assessment, such as a description of the behavior and the times before and after a button press that should be saved. The config file and object store the same information, with the file storing the data even when the system is not running (see Table 3). The config object handles the reading and writing of data to this file as well as the storing of this data during run-time.

4.2.3.2 Capture

The capture interface primarily includes the wireless button previously described but also includes a small ever-present screen on the caregiver's PC (usually a desktop computer in the classroom). After starting CareLog and choosing to capture data as part of a particular FBA, the system begins "listening" for button press events. An instance of the ButtonHandler object is instantiated making the system read to receive key fob events. This object handles all of the communication between the PC and the X10 Key Fob. ButtonHandler sets up a CM11A object on COM2 and listens for address and function events to figure out which button was pressed. Upon receiving an event, it generates the start and stop time for the video that should be captured for the event. In creating the event, a new thread is spawned so that the Event class can handle communicating with the media buffers which ButtonHandler continues listening for subsequent button presses.

While in capture mode, a small screen provides feedback to the teachers about when a button press has been received by CareLog. Teachers can also press the "capture" button in the event that the remote is not working or has been misplaced. By default, today's date is selected, but different days can be selected from the pull down menu to view another day's incidents. An incident can be deleted by pressing its 'Delete' button. Also, the teacher can view the incident in greater detail by clicking the 'View' button which will bring up an Incident Review window in view mode (see Figures 7 and

9). Theoretically, the application can run at all times, and the day simply rolls over on the capture screen to the current day. In practice, however, we found that various issues including losing connectivity with the X10 modules required an automated nightly reboot. This choice mid-deployment required that teachers start the capture interface each morning, which became a privacy-enhancing feature in some ways and a usability problem in others as is described in Chapter Five.

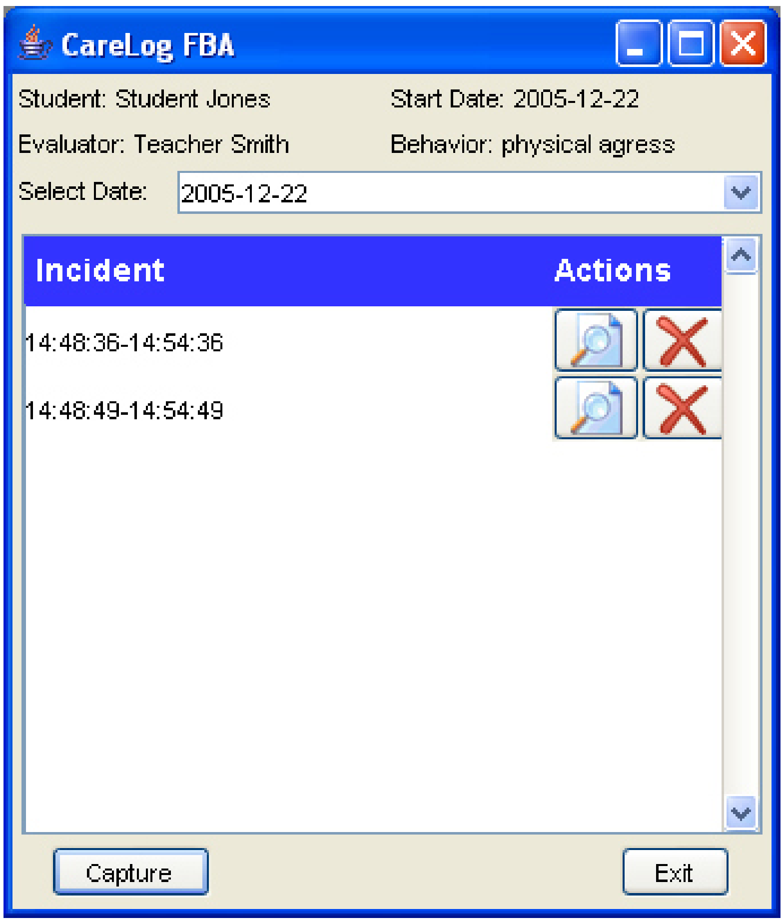

Figure 7: The capture interface for CareLog. When a user clicks the remote, a new incident is displayed on the interface, providing an indicator that the remote action was received. By default, the displayed label will be the timestamp of the incident saved. Once a caregiver provides a label for the incident, however, this label will be displayed along with the timestamp. Caregivers can also click the capture button to actuate an archiving event without the remote. From this interface, users can also choose to delete incidents or to view the videos and metadata associated with them, using the buttons to the right of each incident's label.

4.2.3.3 Viewing and Tagging

CareLog produces some graphs automatically, even without any tagging by the user. For example, simply having the date and timestamps associated with the button pressed allows for the construction of basic frequency graphs and histograms showing the times incidents occurred (see Figure 8).

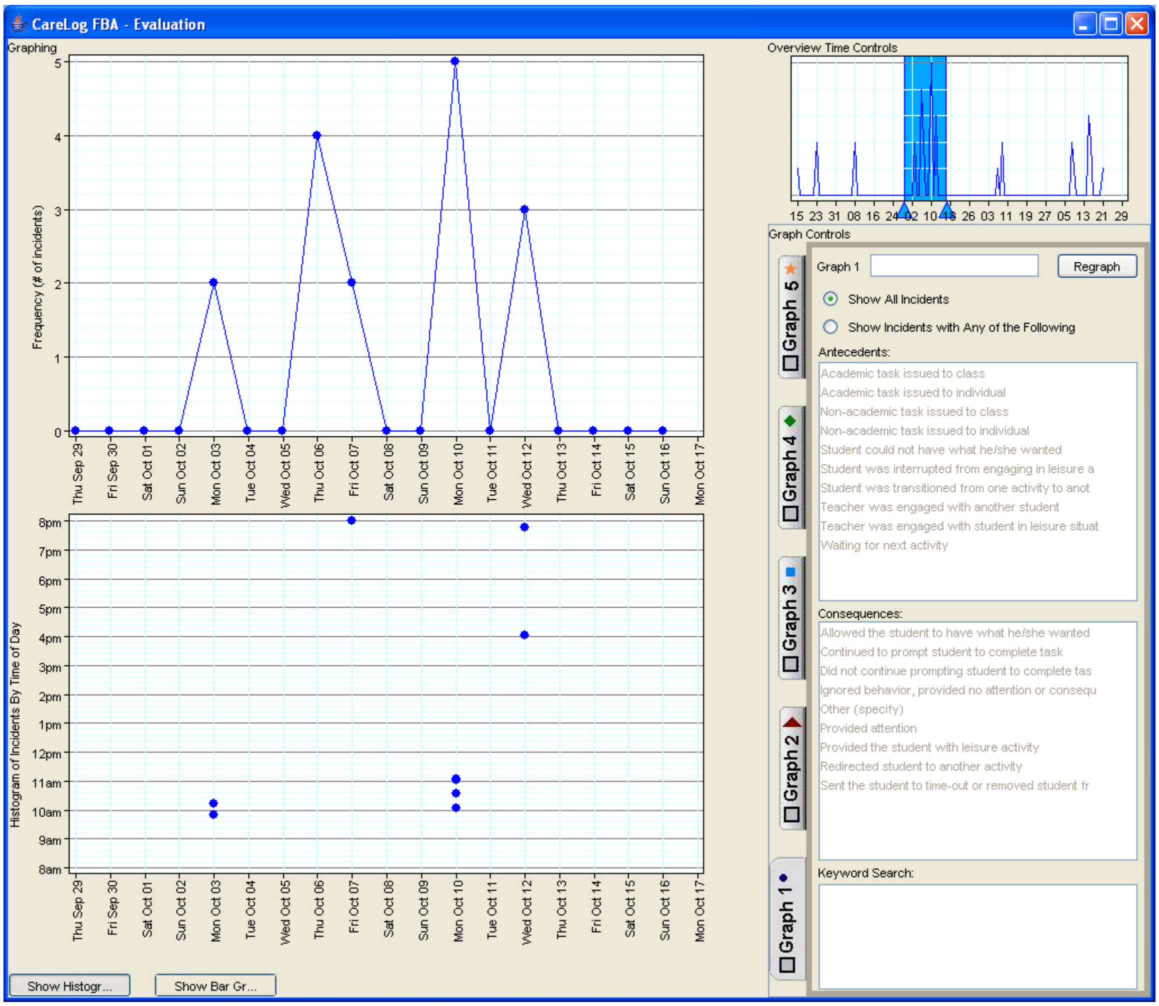

Figure 8: The graphing and analysis interface. The upper right window shows an overview of the available data in graphical format as well as a zooming interface that controls the larger graphs to the left.

Although the basic date and time information can be significant indicators of function for some children (*e.g.* if the behavior always happens before lunch, it may be related to that activity), more data are generally needed. Thus, users of CareLog must label the incidents with meta-data including antecedents, consequences, and other notes. From the capture interface (Figure 7), a user can select to view a particular incident. From the default graphing and analysis interface (Figure 8), a user can choose either to view a particular incident (by clicking the dot that represents that incident on the histogram), to view an entire day (by selecting the dot that represents that day on the frequency graph), or to view a particular selection of data points (by clicking, holding, and drawing a box around the selected points on either graph). Whatever action taken, users will eventually reach the tagging interface for a particular incident.

The tagging interface allows the caregiver who recorded the incidents or another one to go back to the individual incidents and add meta-data such as the hypothesized antecedent and to discard video streams that might not be relevant (see Figure 9). All of the video streams play synchronously with the audio stream and can be controlled using a single slider beneath the bank of four videos. Once all of the data (or at least enough) has been tagged, users will return to the graphing and analysis interfaces to explore this data further. CareLog makes it easy to go back and forth between these interfaces so that caregivers can easily make changes to the tags as their hypotheses about the behavior develop.

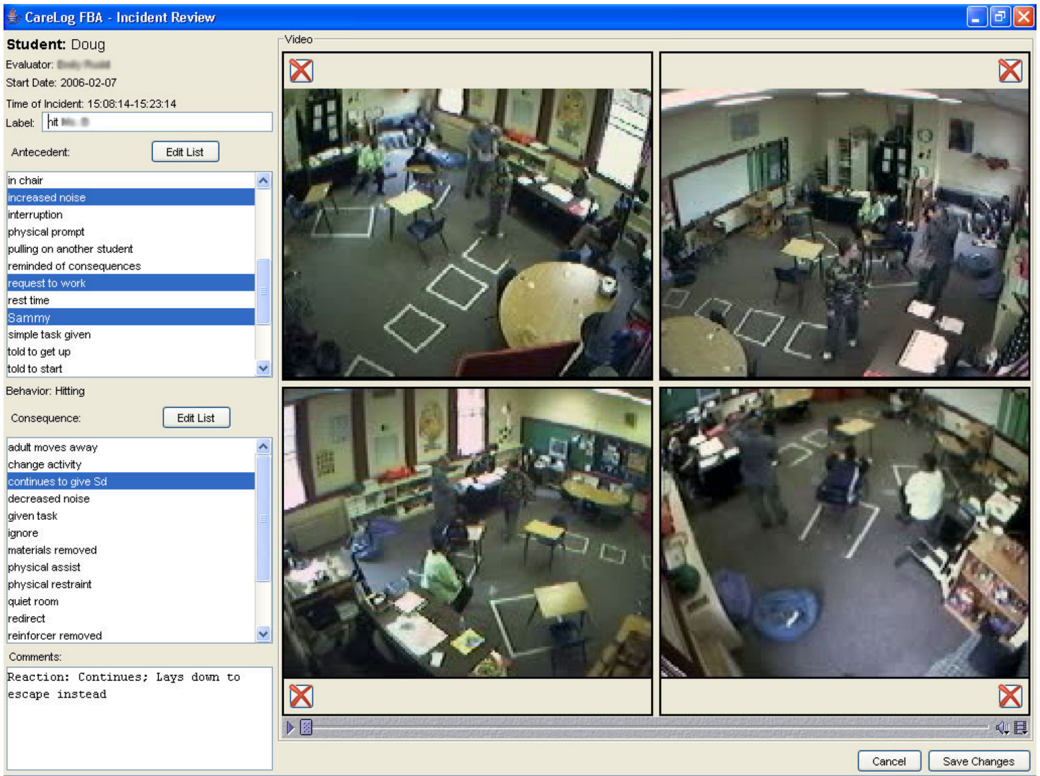

Figure 9: The access interface allows teachers to view all four video streams and one audio feed simultaneously and provide the meta-data required for FBA.

4.2.3.4 Analysis

Finally, the analysis interface provides the graphing capabilities traditionally needed in a functional analysis as well as the ability to "drill down" from the high level graphs into individual incidents and their media streams as described in Section 4.2.3.3. Users can toggle between the histogram and bar graph views while always viewing the frequency graph at the top of the analysis interface. They can create up to five graphs simultaneously using a tabbed interface to filter out data as they make and test hypotheses about the data (see Figure 11). They can also search the freeform notes that they created in the tagging interface for any meta-data that does not easily adapt to the antecedent and consequence labels.

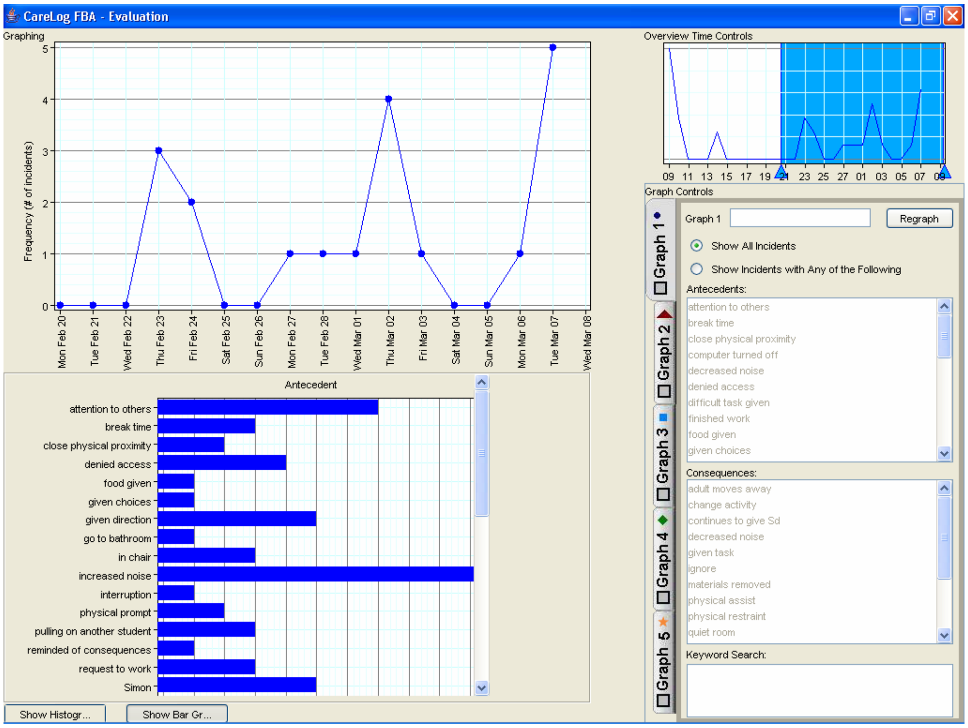

Figure 10: The bar graph option on the analysis interface provides a quick glance for users to the counts of the antecedents and consequences for particular behaviors.

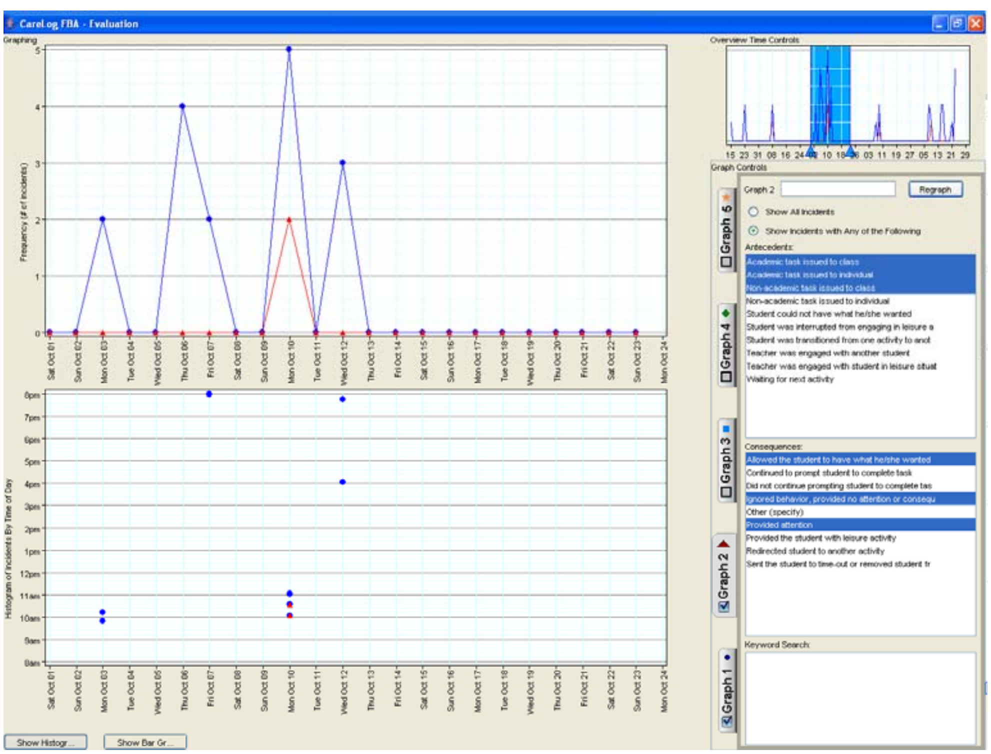

Figure 11: Users are able to view automatically generated graphs that allow for the testing of multiple hypotheses.

One aspect of the analysis interface that was requested and initially designed is the concept of creating reports and the ability to export and to print data from the interface. Due to time and resource constraints, we did not ultimately implement these features, a source of some problems as described in Chapter Five.

4.2.4 CareLog Data Model

The CareLog data model was created based on interviews with behavior specialists. It is meant to be extensible to a variety of types of FBA and of media types (including and in addition to audio and video) and to use with multiple students simultaneously. Thus, all antecedents, behaviors, and consequences are all "codes" with corresponding code_types that indicate their metadata type. Similarly all media is stored in the database with a unique pointer to its location on disk, the room and events to which it is associated and the type of media it is (*e.g.*, audio, video, other sensor stream). The full data model is represented in Figure 12. CareLog's database was implemented using MySQL version 5.

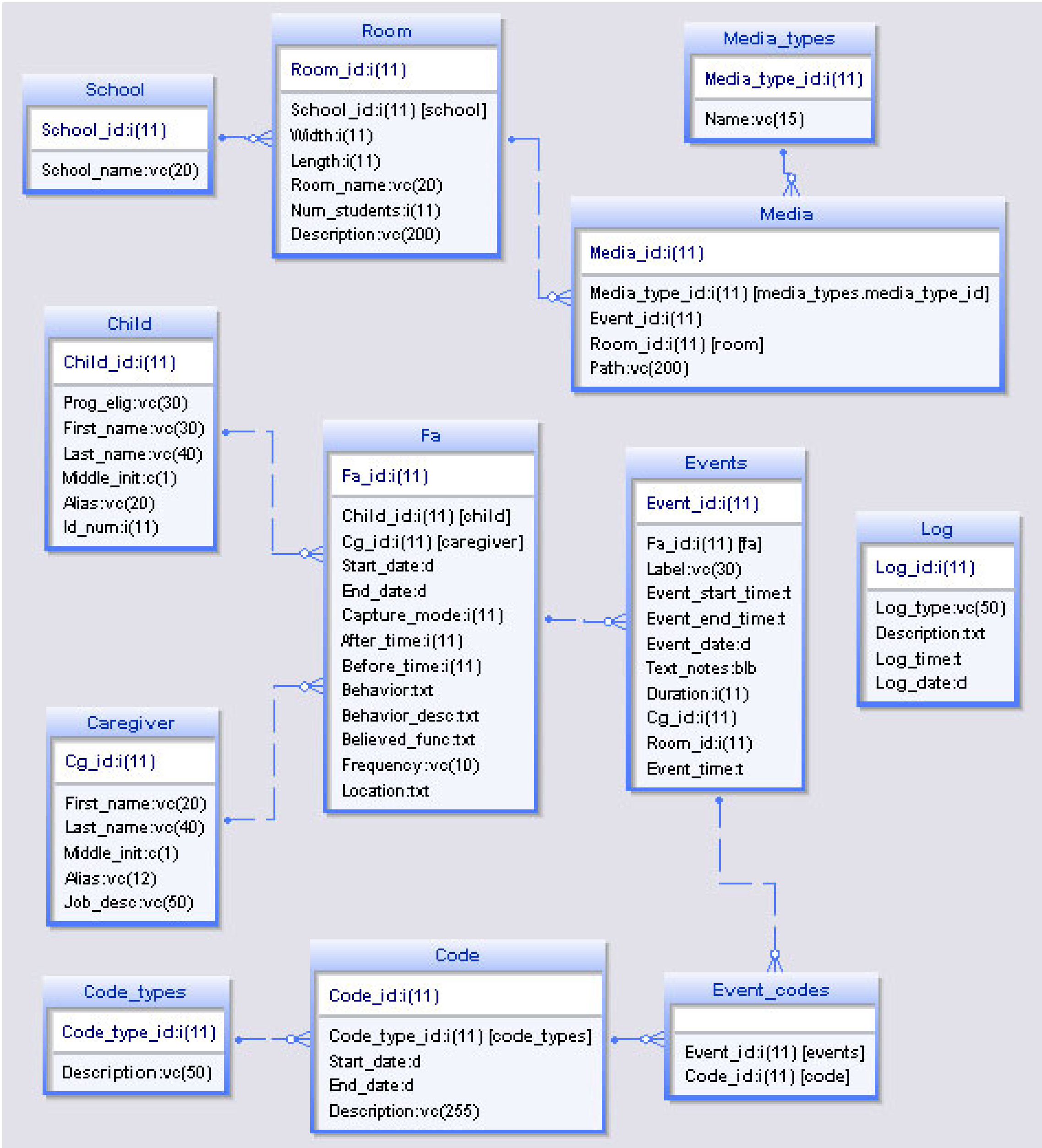

Figure 12: CareLog data model

4.3 BufferWare

BufferWare is a prototype system for supporting the capture of informal activities, such as meetings, in a semi-public space. The purpose of inclusion of the BufferWare project in this work is three-fold. BufferWare provides:

- an example of another application that can use the EBA without any modification from its implementation in CareLog;[16]
- an exploration of the selective archiving concepts meant to provide a compromise between the concerns of capture and the needs for it using a system with open-ended and arguably minimal usage models; and
- a significant contrast class to the use of selective archiving in schools for a narrow and notable purpose.

Thus, my goal with the BufferWare system was to build on past research and understanding about informal note-taking (at meetings or otherwise) and the concepts of selective archiving to develop a flexible system that would allow for informal capture in a particular space. BufferWare includes local capture (buffer services), a local interface for archiving or for purging information from the capture buffers, and a networked access interface to allow users to review data captured with BufferWare from anywhere.

4.3.1 Design of BufferWare

BufferWare provided a platform for studying the ways in which people might appropriate selective archiving technologies for various reasons as well as how people avoid or utlize a space instrumented with such capabilities. Thus, the primary design goal for BufferWare was its flexibility. At the same time, to be useful and likely to be used, it needed to be designed with some purpose in mind, some motivation for use. Based on a light-weight observational study of the space that would eventually be the site of the

[16] Other applications have since been developed using EBA including a commercial home-based hybrid of BufferWare and CareLog, known as BI Capture.

BufferWare deployment over several weeks, I determined that the space was used for three primary purposes:

- Informal meetings and conversations, sometimes over food or drinks
- Individual, alone activities (work, eating, etc.)
- Phone calls

Certainly, the first of these activities affords the most likely use of capture technologies[17]. Thus, it was for these activities that BufferWare was designed.

As outlined in Chapter Three, certain design requirements resulted from formative explorations of the informal capture problem. To review, the needs for informal, everyday capture and note-taking outlined are:

- Inclusion and use of rich media, including both physical and digital artifacts
- Flexibility of the system to allow for a variety of formats and uses of data
- Ubiquity of both capture and access interfaces
- Ability to transcribe and/or translate the data easily
- Minimal interference with primary activities
- Balance of concerns about privacy, surveillance, and control of data with worth of capture
- Ability to add or remove capture services as is appropriate
- Relation of streams of data with minimal manual intervention

Furthermore, Brotherton *et al.* outlined some barriers to capture of impromptu meetings, such as those intended to be supported by BufferWare:

- Cost of starting any capture services

[17] As an aside, against my expectations, at least one person reported using BufferWare to record a phone call of which he wished to remember his side of the conversation.

- Interference of capture services with primary activities
- Lack of structure, which can impede both capture and access

In this section, I describe the design principals derived from both the related work and my formative work in this space. Also presented are the ways the guidelines are addressed in the design of BufferWare. Finally, considerations imposed on the design by the building owners and by Georgia Institute of Technology are outlined.

4.3.1.1 Minimal overhead

During its hours of operation[18], BufferWare runs continuously. In this way, there is no startup cost to the users wishing to save something. They can simply choose to archive the buffered media and to whom to send it. Another primary goal was to minimize the interference with primary activities taking place at in the space chosen for the deployment of BufferWare. Thus, interfaces with which people must interact to save media using BufferWare needed to be embedded in the physical artifacts already present in the space while providing easy access to them. Thus, we designed a tabletop to replace one that was already in the space and embedded a touchscreen interface in it to provide the basic interface to BufferWare (see Figure 13, right). I also considered using two large physical buttons, one for saving and one for deleting, but settled on a screen to provide users the ability to save the media privately as opposed to saving to one giant repository as would have been afforded by the physical buttons.

[18] One of the original design requirements had been that BufferWare would always run. Institutional requirements, however, as described in Section 4.3.1.4 restricted to hours of operation from 8AM to Midnight each day.

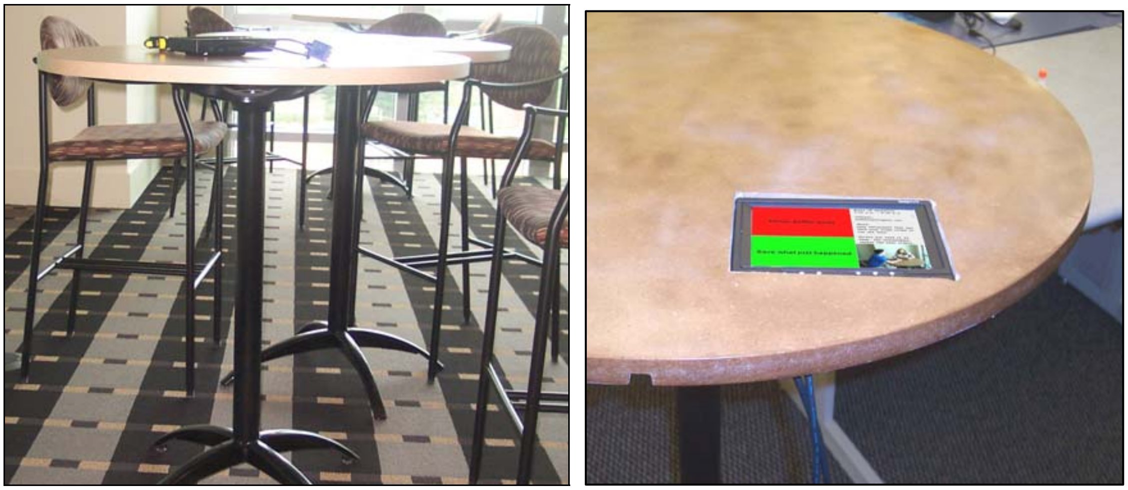

Figure 13: (Left) Location of the BufferWare deployment, a semi-public space on the third floor of a research building in which people commonly have informal discussions and meals.
(Right) The modified tabletop that includes the touch-screen for interacting with BufferWare.

Of course, the choice to run BufferWare nearly continuously could mean that there is slightly more overhead for people wishing *not* to archive something. The very nature of selective archiving and its automatic deletion features are designed to address this very concern. If they trust the system to delete automatically as it is built to do, and they trust

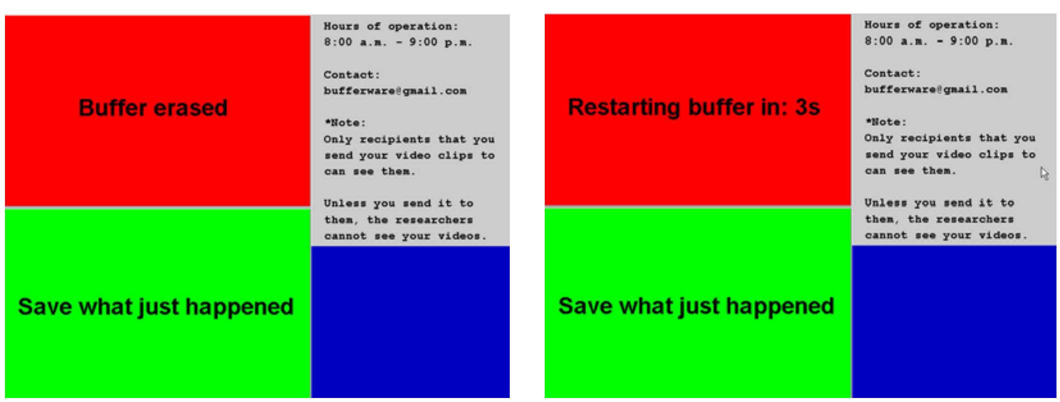

Figure 14: (Left) The BufferWare GUI indicates when the buffer has been successfully erased.
(Right) A countdown indicates when the buffers will restart recording.
The area covered by the blue box in both screen shots displays a real-time view of the camera feed when the system is buffering video.

that no one will come behind them and archive media buffered while they were present, people using the BufferWare space and wanting not to record can do nothing. In practice, however, we were concerned that people would not always trust the system and that even if they did, malicious individuals could still choose to archive things for which they were not present once the primary participants had left the space. Thus, we also provided a delete button. With one press, users can delete everything that is currently in the buffer. Furthermore, recording is delayed for the next five seconds providing users the chance to leave the space without being recorded at all. The countdown of this delay is displayed in the space on the interface that normally houses the delete button (see Figure 14).

Another concern related to minimizing the overhead of system use for an individual rests in the automatic relation of streams of data to one another with minimal manual intervention. BufferWare automatically relates the saved audio, video, and timestamp information to one another. Users can then label the saved media and add commentary. The data model supports other notions, such as indicating who has access to the media, but we did not implement displaying or searching of this meta-data in the BufferWare interfaces. Furthermore, were this service to be available on a larger scale, other easily gathered meta-data should also be included, such as the location at which a clip was saved (always the same in the BufferWare case).

Despite its utility, as uncovered in previous work, automatic transcription and translation of the data was not supported in BufferWare. Furthermore, the ability to download and save those clips was also not supported. Thus, users can not easily take advantage of other automatic transcription technologies using the media saved with

BufferWare. This requirement was deemed to be less important to the overall research questions and thus was not included.

4.3.1.2 Flexibility

Given the wide scope of informal meetings and the express research interest in understanding for what else the concepts of selective archiving might be used, BufferWare needed to be extremely flexible in its possible uses. Thus, all meta-data and media supported were chosen first and foremost for their versatility. Due to the richness of the channels, audio and video are extremely flexible. The downside of this model, of course, is that often the saved content includes much more than might have been relevant. For example, for certain activities, better capture of the clearboard and no audio nor video capture at all might be preferred. These media, however, provide a bit of a catchall for a system that supports a variety of activities. For example, in those cases in which integration of the physical world is important, such as sharing a view of a physical prototype or recording what was written on the clearboard (see Figure 16), users can adopt the video stream in varying ways to capture these items. Thus, we intentionally focused the camera in the direction of one of the three clearboards so that content placed there could be recorded in addition to content at the table itself.

The use of a simple text box for comments also allows for a wide variety of meta-data to be recorded. A significant downside to this approach, however, is retrieval of the information later. We did not implement searching of the meta-data, and clips were only displayed in a simple list sorted chronologically. Thus, visual searches by users were required to find the desired snippet of media.

4.3.1.3 Balancing Access, Awareness, and Intrusiveness

To be useful, people may require ubiquitous access to the services offered by any system designed to support their informal capture needs. We were able to provide this level of ubiquity in terms of allowing people access to their saved clips, by using networked applications to serve the media to them. On the capture side, however, full instrumentation of all of the environments used by people was impractical for this research project. Furthermore, I wanted to understand what people would do with and how they would react to one such environment as a first step. I wanted to constrain BufferWare's capture to a single space to study the reactions to it without causing potentially (and likely) large-scale contentious response. Along these lines, I also posted signs and sent emails about the project and BufferWare's capabilities to all people likely to use the space (all residents of the TSRB). Finally, I also demarked the portion of the space likely to be captured on both audio[19] and video with a stripe of bright blue tape. Of course, the argument can always be made that without true ubiquity, the system was doomed to failure, but persistent continual use was not a requirement to address the research questions at hand.

4.3.1.4 Institutionally or Research Project Imposed Considerations

Some of the most significant influences on the design of BufferWare came not from user needs but from requirements imposed by the fact that the system would be deployed at Georgia Tech and as part of a research project. These requirements were imposed for

[19] Audio is of course not nearly as well constrained as video, but we did tune down the microphone capture dramatically, erring on the side of too little audio captured rather than too much. As it turns out and as is discussed in more detail in Chapter Six, these efforts did not provide enough protection for all those concerned and was prohibitive to the successful use of saved media by those attempting to archive data.

several reasons: property protection considerations of building management, legal concerns from the Institute, human subjects research considerations by the IRB, and our own considerations about the research questions we were asking.

The building management at the Technology Square Research Building (TSRB), including both the computing services staff and the physical facilities staff, required input into the design of BufferWare, because of its potential impact to these facilities. Computing facilities would not allow external access to the BufferWare server via wireless, as is required to serve the saved media to client applications. Thus, I had to request and have installed a network port into the commons space that would house BufferWare. All equipment had to be secured, as well, creating a maze of wiring and security cables surrounding the system. Finally, we could not bring in a new, different table nor embed our touch-screen into the table already present. A compromise was to install a new tabletop with BufferWare's screen in it on a pre-existing table. This tabletop could then be swapped back out at the end of the experimental period.

Georgia Tech legal counsel was consulted because the media saved with BufferWare would be recorded on Georgia Tech property. For example, legal council was concerned that videos might be used to defame someone's character thereby potentially opening the Institute up to lawsuits for libel. I had also originally intended to allow people to save media either to a public space or to their own private space. This choice would have provided an opportunity to explore when and why people might save things publicly as well as to seed the public archives with the research team's videos and thus encourage further use. Again, concern about lawsuits altered the requirements such that archives could only be stored in password-protected private space. Georgia Tech legal counsel also required an agreement to be acknowledged by users at time of saving media that reduces the liability of the Institute to the choice of saving. A final requirement imposed for legal protection was the hours of operation. The reasoning for this constraint was that the majority of inappropriate behavior would occur between midnight and 8AM and that little to no appropriate use of the technologies would take place at these times.

Once categorized as human subjects research, the IRB had to consider appropriate protections and assurances of consent of the research participants. In the end, it was deemed that documentation of consent for everyone using the space would be prohibitive to the research. At the same time, anyone stepping foot in the space should be warned by signage, and every attempt to alert people prior to use of the space should be made. I used emails and signs outside but near the space to serve this purpose.

To help answer the research questions surrounding BufferWare, a few other features were also included. I wanted to provide as many opportunities for anonymous feedback as possible. Thus, on the registration web page, people could learn about BufferWare and also write anonymous comments that were then saved to the database. I also registered a shared email address that anyone on the research team could access for other comments, bufferware@gmail.com[20]. Finally, I chose explicitly to place the audio and video permanently in the space in semi-fixed positions to explore the reactions to and uses of this particular type of setup. Importantly, this choice flies in the face of the user requirement to add and remove capture services with adjustable need for and comfort level with such capture services. In some ways, this choice, and in fact the entire BufferWare project, is thus in line with the concepts of breeching experiments

[20] In retrospect, getting an alias from the College of Computing would have been more appropriate than a gmail address governed by Google's privacy policies not Georgia Tech's. This concern is revisited in Chapter 6.

(Garfinkel, 1985), in which a potentially contentious social practice or technology is introduced to illuminate the inherent social contracts typically present.

4.3.2 BufferWare Hardware

BufferWare included only one camera and one microphone, both attached to one experience buffer server running on one traditional desktop PC. This PC also housed the database, the media archives, and the table-top application for saving or deleting from the buffers. A touch-screen for access to BufferWare's services via a simple GUI was installed by cutting an appropriate sized hole into a craft table top. We also lacquered the table top to match in color the other nearby tables. The microphone used in the deployment was hot glued to the custom table. The camera was mounted on a stair railing out of reach of most passersby and with a direct view of the table and of the clearboard behind it. Wireless motion detectors were used to record activity in the space anonymously (see Figure 15). The X10 listener module for these motion detectors is the same as the ones used in the CareLog installation and was attached to the primary BufferWare server via serial cable. The web site with information about BufferWare and a web-based access interface to saved media are housed on a separate web server.

Figure 15: Example of wireless motion detectors used in the BufferWare deployment.

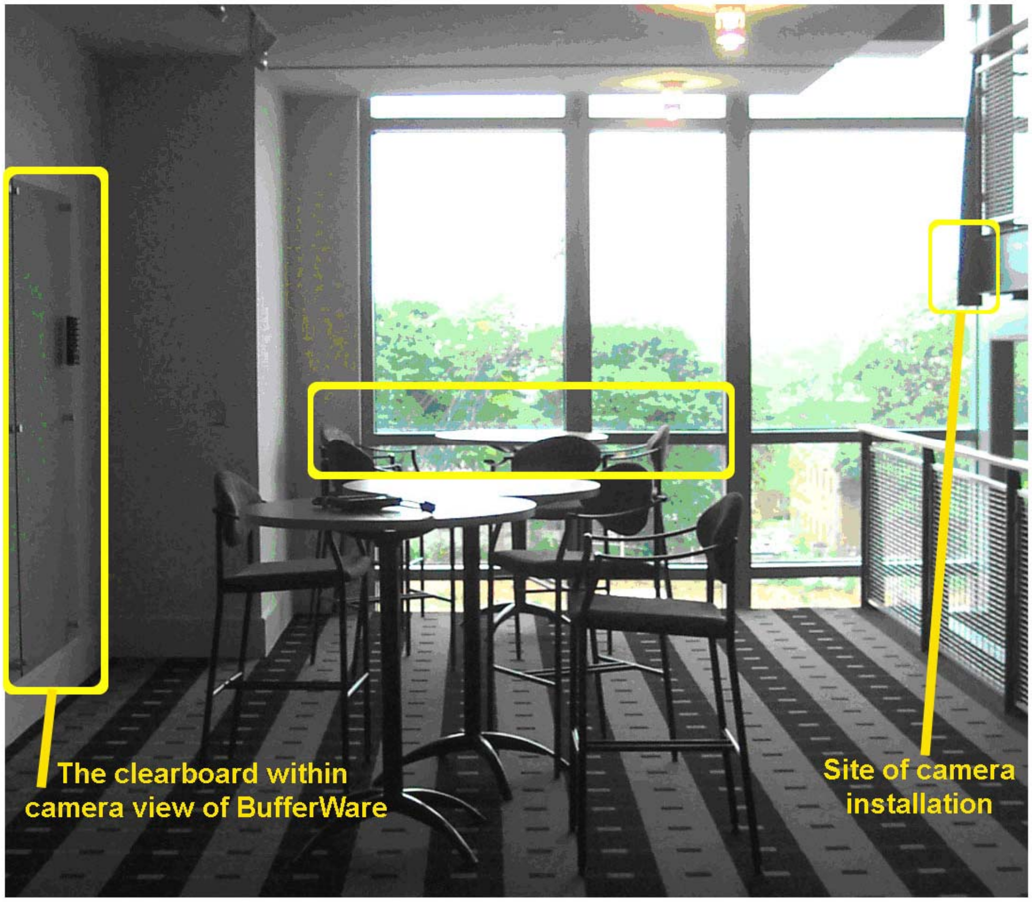

Figure 16: The site of the BufferWare installation. On the left is the clearboard. Center, is the table that was used as the primary site. To the right, is the location of the camera. Motion detectors were placed on the window sill at the far left and far right of the scene to provide triangulation onto the table.

4.3.3 BufferWare Software

The BufferWare System includes local capture (buffer services), a local interface for archiving or for purging information from the capture buffers, and a networked access interface to allow users to review data captured with BufferWare from anywhere. The BufferWare software was developed using Java, the Java Media Framework, and Java Server Pages hosted on a webserver using Apache and Tomcat. The details of the software development are presented in this section.

4.3.3.1 TableTop/Local Services

The BufferWare capture interface runs at all times while BufferWare is running. People use a standard touch-screen embedded in a tabletop to interact with BufferWare (see Figure 17). They can choose with one touch to either delete or save the buffer.

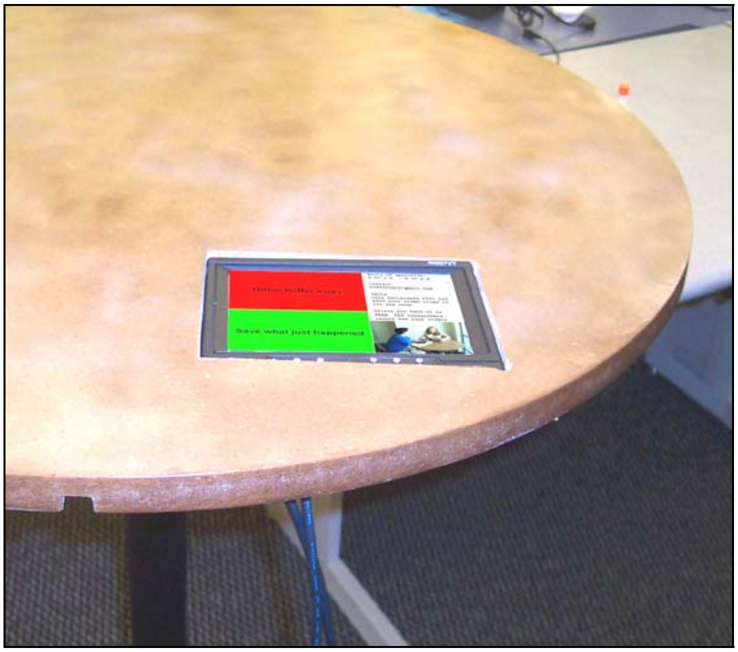

Figure 17: The primary BufferWare interface for saving or deleting data runs on a touch-screen embedded in the top of the table.

Once they choose to archive information, A timeline shows the buffer that is available. Users can choose from within the available buffer to save (see Figures 18, 19). Originally, they could also choose to whom to provide access to the media by entering their email addresses. In this way, users could not only send information to themselves for review but also share information with others. If an address belonged to someone who already was part of the system, they received an email indicating they have a new piece of media and see a new media file appear in their list of available resources. If they were not, they received an email requesting that they register for use of the service. Originally, BufferWare provided this form with a soft keyboard for entering email addresses of people who could receive access to the media being saved. In this way, users not yet registered could still save media but would be forced to register prior to viewing the media (see Figure 18). Use of the soft keyboard was reported to be too difficult for most people, however. A revised version of the interface, in use for most of the deployment, allowed people to pick from a list of registered users or create a new user through the interface (see Figure 19). This solution worked well for the number of users registered but would certainly not scale well. When saving, a user also consents to be part of the study and that they have asked to save this information.

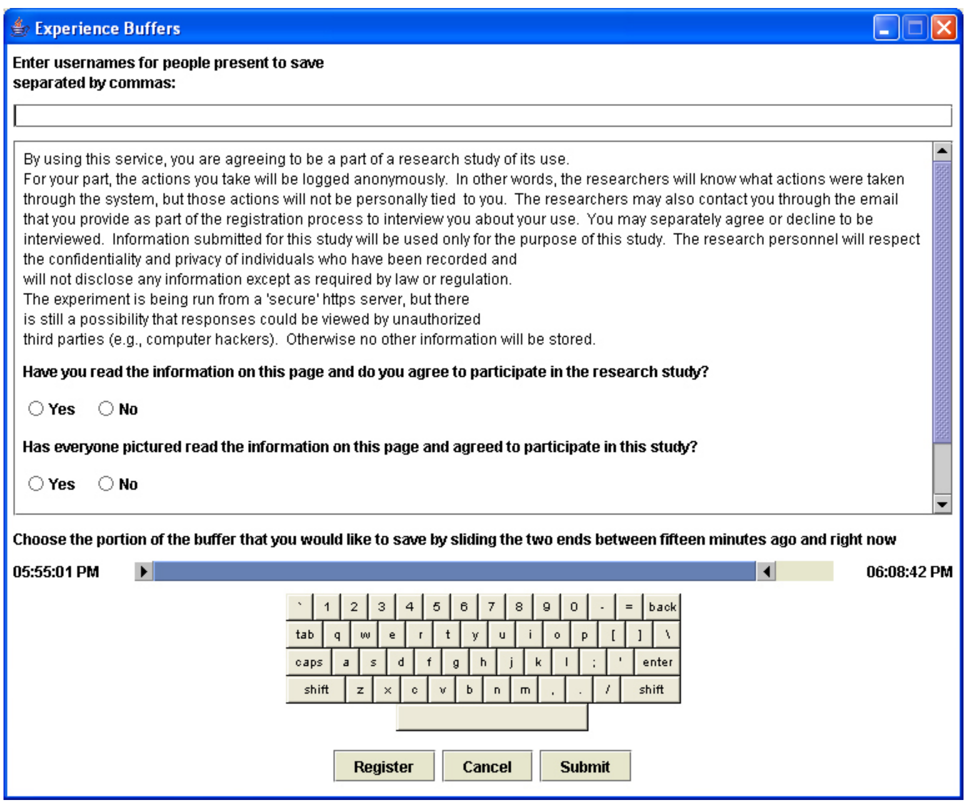

Figure 18: The original interface for archiving media in BufferWare.

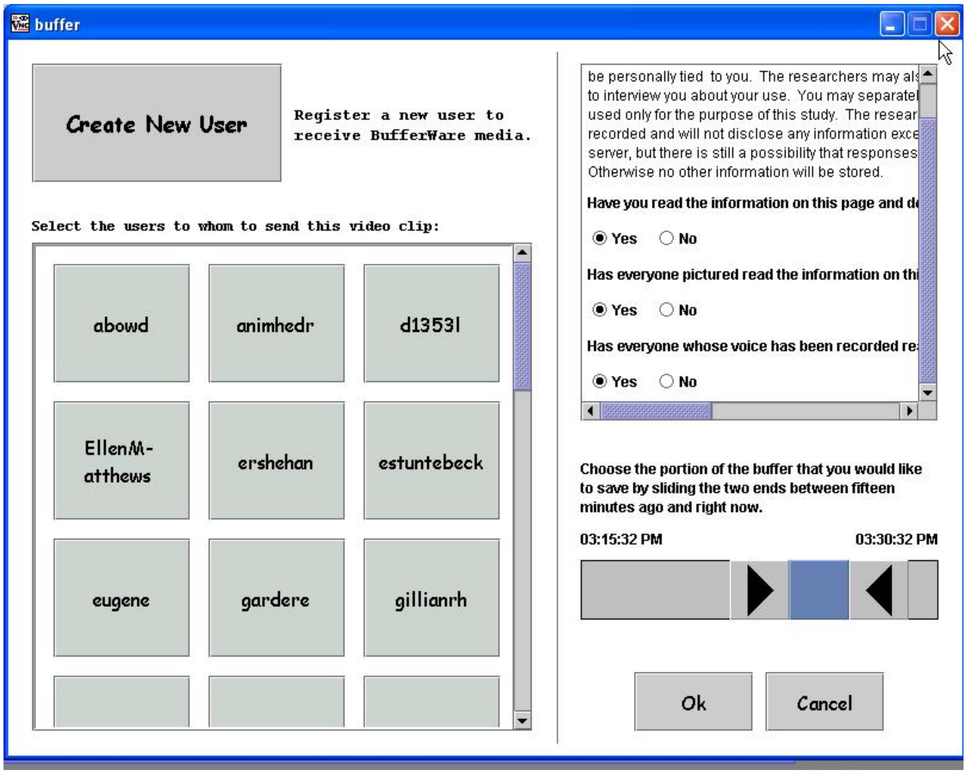

Figure 19: Revised interface for archiving media in BufferWare.

4.3.3.2 Networked Access Services

Through two networked access interfaces, users can replay any media streams that they have saved, add comments, and review comments they may have made earlier with a downloadable access application. Only registered users can access any information, and those users can only access information saved to their profile.

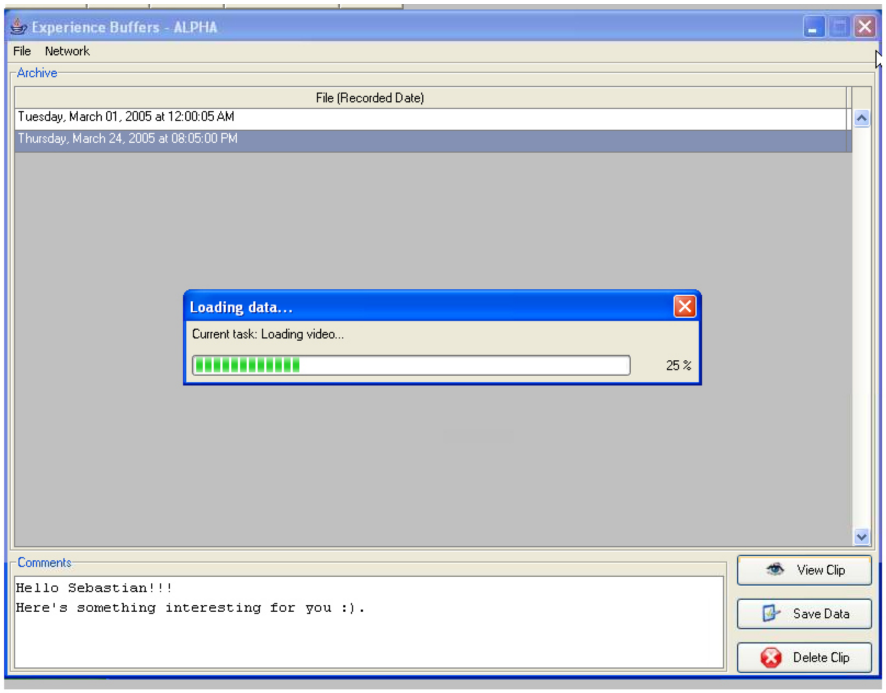

Figure 20: When a user logs into BufferWare, they are shown a list of media clips stored. When one is selected, the comments associated with it are displayed in the bottom window. Users can edit comments directly there and save them, delete the clip entirely, or choose to view the clip. Here, you can see that the user has chosen to view a clip that is now being loaded.

Users can review media clips they have saved through a simple downloadable Java application. When they log in to the BufferWare access application, they see a list of all the media clips that were saved to their accounts (see Figure 20). From there, users can choose to replay a media clip including audio and video (see Figure 21). They can also add or edit the current annotations about the clip. A downloadable Java application was chosen for its cross-platform compatibility.

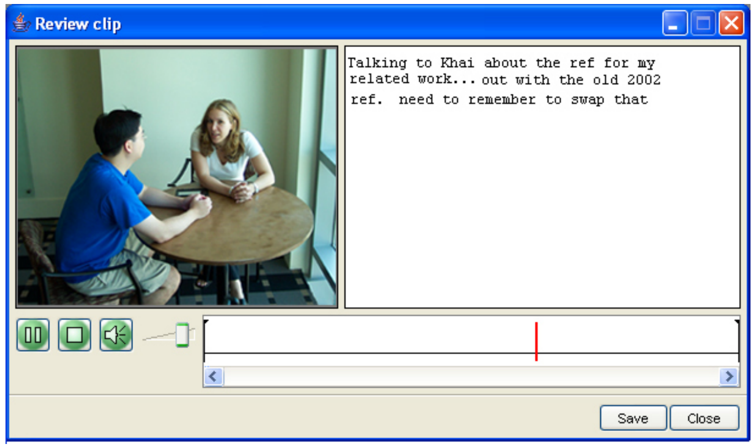

Figure 21: Once a user chooses to view a clip, a new window opens containing controls to play the saved media and displaying the comments window. If a video clip is present, it will be displayed in the upper left corner, if not, only the audio will play. The simple controls allow for pausing, stopping, and playing as well as more detailed navigation through use of a timeline and associated scrub. Users can save any edits they make to the comments or simply close the window and return to the outer menu.

Given the low-need of most of the media, however, downloading and installing a separate application appeared to be too much of a burden for people to overcome. Thus, I also implemented a web-based service for accessing media that worked in much the same way as the downloadable application. Users still need to log in to the system to access their full list of archives. Once they are authenticated, they can manage user settings (*e.g.* password, emails, etc.) and view archived media (see Figure 22).

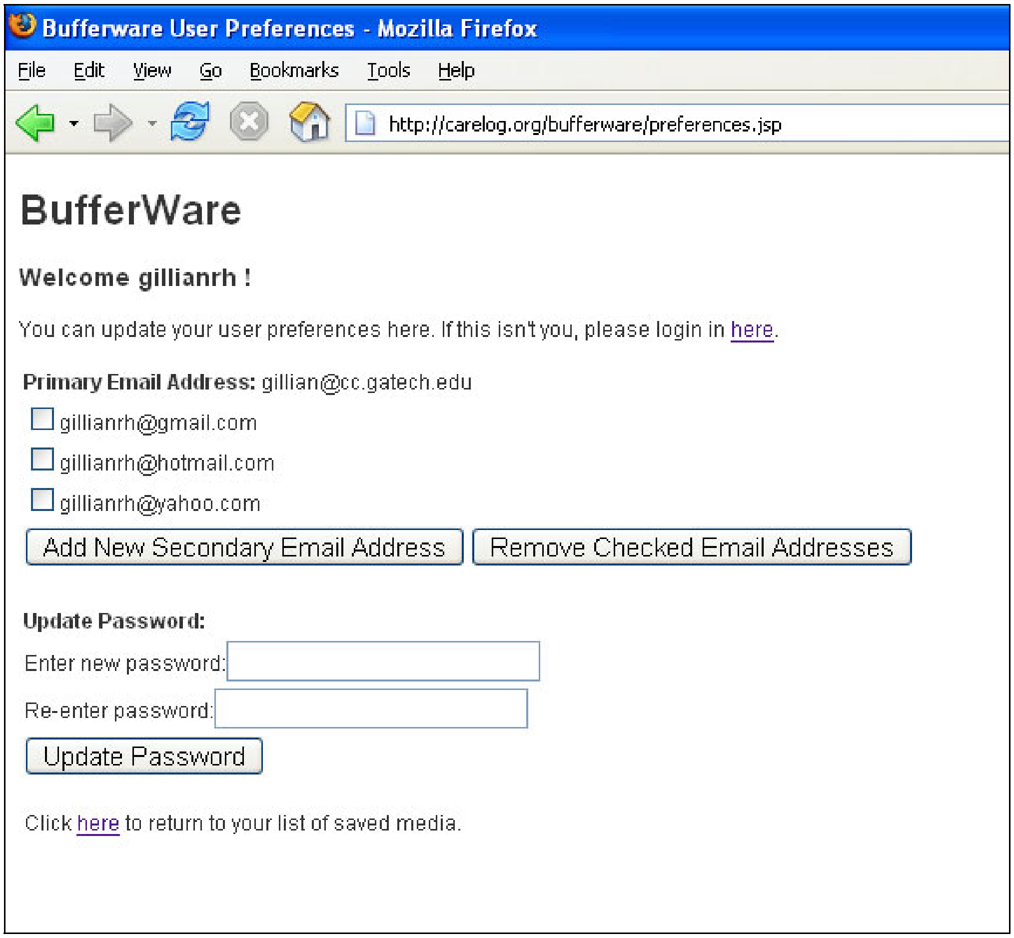

Figure 22: User preferences management interface to BufferWare.

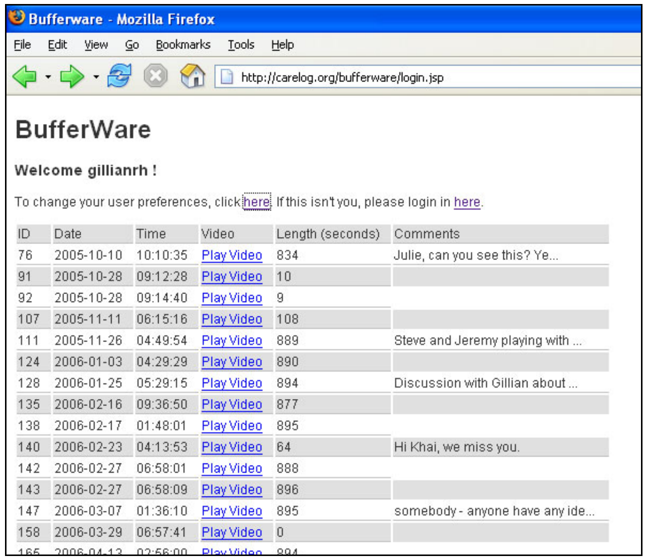

Figure 23: (above) Once logged in to the web interface, a user will see the files listed.
(below) If a file is chosen to be viewed, a new window will be loaded with the file and any comments. By default, BufferWare uses whatever media player is defaulted for use by the user's web browser preferences. Compatibility issues abound, but Internet Explorer and Windows Media Player consistently worked. Thus, we provided a message encouraging that combination for viewing the videos.

4.3.4 BufferWare Data Model

The BufferWare data model was created to be as simple as possible for the particular needs of the BufferWare application. Thus, each archive record includes a pointer to one audio file and one video file and a comments field. The full data model is represented in Figure 24. BufferWare's database was implemented in MySQL vesrsion 5.

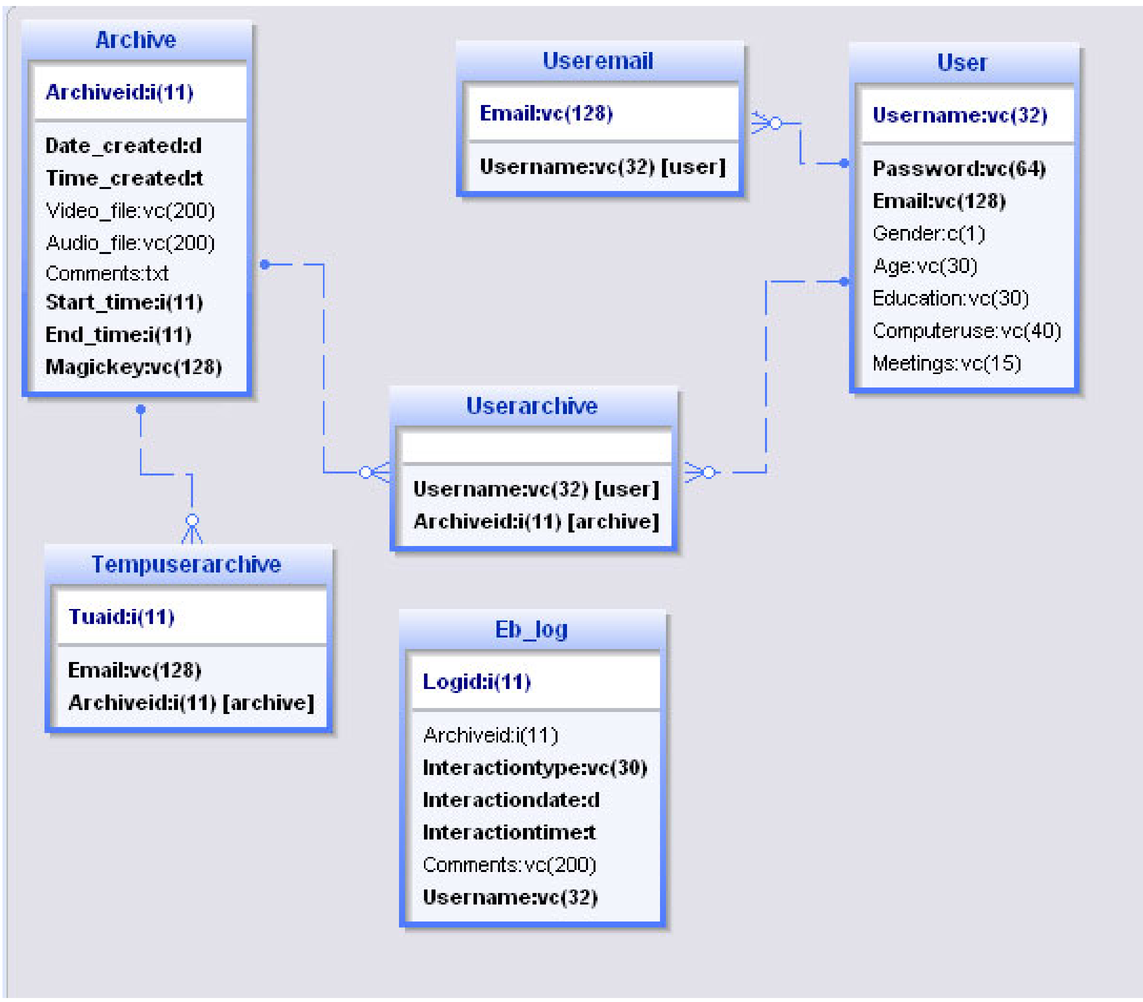

Figure 24: BufferWare data model.

CHAPTER 5

CARELOG DEPLOYMENT AND EVALUATION

I deployed and evaluated CareLog in a local school setting over five months. Four teachers at a special school for behavior disabilities, each used both traditional and technology enhanced methods for conducting FBAs as part of this quasi-controlled study. The study design was a mix of within and between subjects designs in that each teacher experienced both conditions, but they conducted each FBA with a different student for a total of eight students. The conditions were counterbalanced, with two teachers using the technology enhanced FBA process first and two using the traditional pen and paper method first. Teachers were randomly assigned to groups and thus, the students they chose as behavior intervention candidates were also randomly assigned to treatment conditions.

All participants were teachers at a single site, an in-center facility for children with dual disabilities (DD), autism, and severe emotional and behavioral disorder (SEBD). This site also includes behavior specialists as part of a program called Technical Assistance for Severe Behavior (TASB). These specialists often conduct FBAs in classrooms, assist the teachers with behavior plans, and work with children directly on behavior management both within and outside of the classroom setting. Outside of the classroom setting, they also perform clinical style functional behavior analyses[21]. Some of these specialists participated in the design sessions to create CareLog. This school provided an opportunity for us to work with teachers with a range of experience from first year in this setting to 3 years (all had worked in special education for a minimum of a year outside this setting). Furthermore, all of these teachers work in small classrooms (4 to 8 students each) with students who all have diagnoses with cognitive and behavioral disabilities, thus making the environment more amenable to behavior modification, and parents and guardians generally more supportive.

Several measures were used to study the impact of CareLog on the teachers and the FBA process. These metrics included both subjective and objective measures and both qualitative and quantitative methods. I observed the numbers of days and incidents used for each assessment and the percentage of incidents that were not recorded during this same time period. I also interviewed the teachers and asked them to complete questionnaires with background information and questions specific to behavior assessment, video capture, and CareLog. The NASA Task Load Index (NASA-TLX) (Hart and Staveland, 1988) was used to assess workload of each method for conducting FBAs. Finally, all of the assessments prepared by the teachers were experimentally verified using functional behavior analysis in a controlled setting. In this Chapter, I describe the method and results of this evaluation.

[21] Functional Behavior Assessment involves the collection of interview and observational data from everyday interactions. Functional Behavior Analysis involves the systematic testing of hypotheses about behavior through the addition and removal of stimuli in a controlled setting.

5.1 Training

Prior to conducting any FBAs, all teachers completed a training course that included information on both FBA and CareLog. Three of the four teachers who ultimately completed the assessment (Teachers A, B, and D) received this training as part of a five hour in-service training that included:

- 3 1/2 hours of training on the process and scientific methods involved in conducting FBAs[22];
- one hour of training devoted specifically to use of the technology for the technology enhanced condition[23]; and
- 30 minutes of training with regard to the questionnaires, daily forms, and interviews that would be required as part of the study.

One teacher, teacher C, also participated in this training session, but ultimately was unable to complete the study. She accepted a different position within the school and was no longer eligible for the study, because she was no longer the primary teacher in a classroom. Thus, I enrolled Teacher E on recommendation of school staff to replace her. Teacher E received her training during before and after school hours, an hour or two at a time.

As part of their training, teachers identified two children each in their rooms with severe behavior. They then described the behavior and began an operational definition of it. The FBA trainer and researcher on this project, Dr. Juane Heflin, assisted them in

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[22] Training on functional behavior assessment was designed by Dr. Juane Heflin, a specialist in autism and behavior management. Dr. Heflin also delivered this training at the all day session. The PowerPoint slides used for this session are attached in Appendix C.

[23] Delivered by me and attached in Appendix D.

creating appropriate operational definitions during training[24]. Finally, they listed these definitions and hypothesized functions of the behaviors on note-cards that I collected. During the time period of the study but prior to the student's involvement with an FBA, one student (from classroom D) moved to a different room (in Classroom E). The teacher in the receiving room chose to include that student in the study as part of her portion of the study. Another student (from Classroom A) did not demonstrate the problem behavior of intereste after five weeks of inclusion in the study. In that room, the teacher identified a third student to include based on this absence of behavioral incidents. She identified his behavior and recorded her hypothesis about the function of that behavior prior to enrolling him in the study. Finally, one student passed away during the course of the study. Enough behavioral incidents had been collected at the time of her death for the teacher to conduct the assessment and complete a final report[25].

The study was conducted over a five month period. During that time, 109 days were actively spent collecting data for the assessments[26]. Each teacher spent an average

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[24] School staff and I assisted Teacher E with her operational definitions.

[25] The child's death was reported to the Institutional Review Board at our institution and ruled unrelated to the study. The student was taken ill shortly before Spring Break at the school and passed away shortly after. Sadly, her behavior worsened greatly in the last week in which she was in school and part of the study, potentially due to the onset of her illness. She was extremely well liked at school by both teachers and staff, and I grew to care for her very much in the brief months that I knew her. Members of the school staff and the research team participated in various mourning activities, and we all worked together to craft appropriate responses to the other students in her classroom and school. For my part, I was surprised to encounter such considerations in computing research and feel fortunate to have done so in a protected environment that included advisement by Dr. Heflin, Dr. Abowd, and Dr. Grinter. I was also reaffirmed in my desire to develop technologies that help teachers understand student behavior, hopeful that such patterns as those that were noticed retrospectively in this student's behavior may become apparent in a more timely manner helping to speed diagnoses and potential improve their healthcare and educational activities.

[26] Some days are double or triple counted in this number, because multiple children were being assessed by the different teachers simultaneously.

of nearly 30 school days (approximately six weeks) as part of the study, with an average of 13.6 days spent per student on the data collection portion of an FBA (see Table 9 for more details). During this time, teachers collected data on a large number of incidents. In both the pen and paper and CareLog treatments, they chose to delete or disregard portions of this data for various reasons (*e.g.,* erroneous "clicking" and actuating of the system, incomprehensible handwriting on the paper forms, etc.). Ultimately, 245 incidents were used as part of their assessments, with an average of 30.6 incidents per student assessment (min= 15, max = 64, σ= 15.8, see Table 16 for more details).

I distributed questionnaires during the training to gather background information and to measure teacher perceptions about the technology, video recording, school records, and privacy and security of information. Each teacher completed three surveys: one during training and prior to conducting any assessments and one after each assessment. This model provided for measurements of any changes in perceptions after each process as well as a venue for specific questions about CareLog after its use.

5.2 Deployment Evaluation Results

Central to the evaluation of CareLog was the ability to test some essential hypotheses and assumptions regarding the technology's ability to augment and enhance behavior management practices in a real educational setting. Thus, fundamentally teachers should be at least as good at determining a clinically verifiable function of the behavior using CareLog as with traditional pen and paper methods. Furthermore, these captured video segments should be usable by teachers and other interested stakeholders as part of a larger behavior management program. Finally, teachers should be comfortable with the system and ideally use it for even more than just assessing severe problem behavior.

I hypothesized that we might also observe significant quantitative differences in the outcomes of these processes. The outcomes specifically measured included the perceived workload of the teachers, the efficiency with which data could be captured, and the effect on teacher and staff experiences in their daily activities. I hypothesized that classroom staff could capture more incidents in less time with less stress. In part, I imagined that staff would miss fewer incidents and be relieved of some burdens due to the efficiency and ease of the capture. I also hypothesized that the ability for the teacher to review captured incidents would diminish the number of false positives, that is times the staff noted an incident that did not in fact fit the definition of the behavior the teacher was trying to track. In this section, I detail the ways in which we validated these hypotheses and uncovered some other surprising benefits of CareLog use.

5.2.1 Teacher Communication and Data Sharing

On average, teachers reported communicating about the child being assessed with people in the school the most, then the parents, and least with people outside the school other than the parents. Teachers reported that the particular dynamics of these communication patterns, the relationship with the individuals involved, and the needs of the particular student were the sources of variation in these values, and that our experimental protocol and technologies had little to do with these effects. I cannot verify all of these reports, because I did not study the communications without our protocol in place. There appeared to be little to no difference, however between the CareLog and pen and paper conditions in terms of reported communications (see Table 4). There were however differences between the parties with whom the teachers were communicating (see Table 5).

Table 4: Results of questions about the regularity of communications about each child. Respondents selected from a range of choices with 5 being "multiple times per day", 4 "once a day", 3 "a few times per week", 2 "once a week, and 1 representing "less than once a week." Both matched two-tail t-tests and chi-square analyses are presented.

	CareLog							Pen and Paper							Chi-square analysis		p: paired t-test
	1	**2**	**3**	**4**	**5**	**μ**	**σ**	**1**	**2**	**3**	**4**	**5**	**μ**	**σ**	**χ^2**	**p**	
Parents	0	0	2	1	1	3.75	0.96	1	0	0	3	0	3.25	1.50	5	<=0.20	0.49
In school	0	0	1	0	3	4.5	1.00	0	1	0	1	2	4	1.41	3.2	<=1.00	0.18
Out of school	2	1	0	1	0	2	1.41	2	0	1	1	0	2.25	1.5	2	<=1.00	0.39

Table 5: Communication Preferences by Party. There were significant differences when the population with whom teachers were communicating was tested across both conditions.

	1	2	3	4	5	Total
Parents	1	0	2	4	1	8
In-School	0	1	1	1	5	8
Out of School	4	1	1	2	0	8
Total	5	2	4	7	6	24

Degrees of freedom: 8
Chi-square = 15.7
p <= 0.05.

When queried about control of data, privacy, and concerns about sharing information, teachers generally reported being willing to share their data. The variation in responses is minimal, with the range of average responses about sharing hovering between *agree* (4) and *strongly agree* (5) with statements that all began "I am willing to share data I collect about a child with…." Interestingly, despite reporting communicating more with people in school than with parents or other individuals outside of the school, they reported being least willing to share their data with other school employees (μ= 4.125, σ = 0.35). Furthermore, all four teachers wrote comments about the statement regarding other school employees indicating that consideration about whether that staff member works with the student or whether they believed it might benefit the students would factor into their decision. For example:

“if applicable to student benefit or safety purposes”

“if they work with the child”

“T.A.S.B., social worker, principal (only people involved”)

No statistically significant differences exist between the responses to these statements after the CareLog case and after the Pen and Paper case (see Table 5 for more details). There was a trend towards being more likely to share data “if [the teachers] think it will improve the child’s care." Also, there was a trend towards being less likely to choose to share data in the CareLog cases case for school staff and doctors when compared with the traditional method.

Table 6: Teachers reported generally being willing to share collected data about a child with parents, other school staff, and the child's doctor. Respondents were asked their level of agreement with statements with 5 being strongly agree and 1 being strongly disagree. Tests were also run comparing the first from the second assessment, but no differences were found due to order effects.

I am willing to share data I collect about a child with…	**CareLog**		**Pen and Paper**		**Overall**		**p: paired t-test (CL vs. PP)**
	μ	**σ**	**μ**	**σ**	**μ**	**σ**	
Parents if they ask	4.75	0.50	4.75	0.50	4.75	0.46	1.00
Parents if I think it will improve care	4.75	0.50	5.00	0.00	4.875	0.35	0.39
Other school staff if they ask	4.00	0.00	4.25	0.50	4.125	0.35	0.39
Other school staff if I think it will improve care	4.50	0.58	5.00	0.00	4.75	0.46	0.18
Child’s doctor if asked	4.50	0.58	5.00	0.00	4.75	0.46	0.18
Child’s doctor if I think it will improve care	4.75	0.50	5.00	0.00	4.88	0.35	0.39

Table 7: Chi-square analysis of data sharing practices. None of these results showed significance, but there is a trend towards less of a willingness to share data when it includes videos (CareLog condition). It should be noted however, that no one ever selected 1, 2, or 3 meaning that they reported generally being willing to share data.

I am willing to share data I collect about a child with…	CareLog					Pen and Paper					d.f.	χ^2	p
	1	2	3	4	5	1	2	3	4	5			
Parents if they ask	0	0	0	1	3	0	0	0	1	3	1	0	<=1.00
Parents if I think it will improve care	0	0	0	2	2	0	0	0	0	4	1	2.67	<=0.20
Other school staff if they ask	0	0	0	2	2	0	0	0	0	4	1	2.67	<=0.20
Other school staff if I think it will improve care	0	0	0	1	3	0	0	0	0	4	1	1.14	<=1.00
Child's doctor if asked	0	0	0	1	3	0	0	0	0	4	1	1.14	<=1.00
Child's doctor if I think it will improve care	0	0	0	2	2	0	0	0	0	4	1	2.67	<=0.20

Table 8: Chi-square analysis showing significant differences between willingness to share data and the groups of stakeholders

I am willing to share data I collect about a child with…	1	2	3	4	5	Total
Parents if they ask	0	0	0	2	6	8
Parents if I think it will improve care	0	0	0	2	6	8
Other school staff if they ask	0	0	0	7	1	8
Other school staff if I think it will improve care	0	0	0	1	7	8
Child's doctor if asked	0	0	0	1	7	8
Child's doctor if I think it will improve care	0	0	0	2	7	9
TOTAL	0	0	0	15	34	49
Degrees of freedom: 5 Chi-square = 15.195, $p <= 0.01$						

Table 9: Chi-square analysis showing significant differences between willingness to share and reason for sharing

I am willing to share data I collect about a child …	1	2	3	4	5	Total
if they ask	0	0	0	11	13	24
if I think it will improve care	0	0	0	4	21	25
TOTAL	0	0	0	15	34	49
Degrees of freedom: 1 Chi-square = 5.13, $p <= 0.025$						

5.2.2 Experiences with FBA

The teacher participants had little experience with FBA. As described in Chapters 3 and 4, it can be a very difficult process to complete in a classroom environment. Thus, a set of questions was included in the surveys to assess overall perceptions about FBA (see Table 10). Overall, the teachers were comfortable with conducting FBA in general with the minimal training they received. Furthermore, although they did report it to be at least slightly demanding, they agreed generally that it was valuable to their work, increases confidence in assessing and changing student behavior, and effectiveness as a teacher. Minimal differences in responses between the CareLog and pen and paper conditions were observed. The minimal trends indicate the CareLog may be more straightforward and may result in slightly more confidence, perceived effectiveness, and perceived involvement and control of both behavior and data management.

Table 10: Responses to statements about FBA: Teachers were asked how much they agree with statements on a scale from 1 (strongly disagree) to 5 (strongly agree).

	CareLog							**Pen and Paper**							**chi-square analysis**		**p: paired t-test**
	1	**2**	**3**	**4**	**5**	**μ**	**σ**	**1**	**2**	**3**	**4**	**5**	**μ**	**σ**	χ^2	**p <=**	
Conducting an FBA …																	
…was straightforward	0	0	1	1	2	4.25	.96	0	0	1	3	0	3.75	.50	3	1	0.18
…was complicated	0	4	0	0	0	2.00	.00	0	2	2	0	0	2.50	.58	2.67	.2	0.18
…was demanding	0	1	1	2	0	3.25	.86	0	0	3	1	0	3.25	.50	2.33	1	1.00
…increases my confidence that I can change this child's behavior	0	0	0	3	1	4.25	.50	0	0	1	3	0	3.75	.50	2	1	0.39
…increases my effectiveness as a teacher with this child	0	0	0	2	2	4.50	.58	0	0	1	3	0	3.75	.50	3.2	1	0.22
…increases my effectiveness as a teacher with other children	0	0	0	2	1	4.33	.58	0	0	1	1	2	4.25	.96	1.56	1	0.74
It is valuable to my work if I can conduct an FBA	0	0	0	2	2	4.50	.58	0	0	0	3	1	4.25	.50	0.53	1	0.39
I feel involved in the management of …																	
…data collected in my classroom	0	0	0	1	3	4.75	.50	0	0	0	2	2	4.50	.58	0.53	1	0.64
…behavior and students in my classroom	0	0	0	1	3	4.75	.50	0	0	0	2	2	4.50	.58	0.53	1	0.38
I am able to handle behavior problems in my classroom	0	0	0	2	2	4.50	.58	0	0	0	2	2	4.50	.58	0	1	1.00
I understand why the children in my classroom show inappropriate behaviors	0	0	0	3	1	4.25	.50	0	0	0	3	1	4.25	.50	0	1	1.00
I was able to record everything that I wanted to say about an incident																	
…at the time of the incident	0	2	1	1	0	2.75	0.96	0	3	1	0	0	2.25	0.50	1.2	1	0.18
…eventually	0	0	0	2	2	4.50	0.58	0	1	1	2	0	3.25	0.96	4	1	0.08

5.2.3 Successfully Assessing Student Behavior

A primary goal of this research has been to ensure that teachers who have minimal experience with conducting FBA's can, in fact conduct them in their classrooms successfully. As described in Chapter Two, the core idea behind FBA is that every behavior has a goal or a function. These functions can include getting access to something (tangible) or to someone (attention), avoiding something (usually called demand or escape), attenuating pain (such as when people apply pressure to the temples to relieve a headache), or sensory stimulation (also referred to as automatic reinforcement). The fundamental measure of success for an FBA is traditionally whether the resultant function, as described here and fit into one of these categories, determined by the teacher can be verified in an experimental setting.

Traditionally, experimental analyses involve controlled introduction of the conditions hypothesized coupled with control conditions during set time periods. We conducted experimental verifications for seven of the eight students (see Table 11). The eighth student passed away during data collection, and so no clinical analysis could be completed after the assessment. Some students demonstrated multiple functions. Thus, with the seven remaining students, five of the student functions were fully verified. Four were not verified, and two functions were observed clinically that had not been determined during the classroom assessments. One function could not be verified, because the teacher hypothesized the student's behavior was undifferentiated, meaning it may be a sensory issue or automatically reinforced. It is important to note that not being able to verify a function of a behavior in a clinical setting does not mean the teacher was wrong. For example, in one unverified case, the teacher determined that Derrick[27]'s function was related to attention, particularly attention from certain staff members. These conditions are difficult, if not impossible, to replicate outside of a classroom setting, thus exemplifying one of the major problems with clinical analyses that have driven so many behavior specialists to focus on natural settings, such as the classroom or the home. Detailed descriptions of the clinical verification process for each student along with the graphs reporting the results from those sessions is included in Appendix H.

[27] All names of students in this dissertation are pseudonyms.

Table 11: Each teacher hypothesized about their students' functions prior to the study beginning. They then determined a function based on their assessment data. Finally, we attempted to verify most of those functions using best practice clinical procedures.

Child	Hypothesized Function	Teacher FBA Determination	Functional Analysis (FA)	Verification
Derrick	sensory/automatic	attention	no behavior	No
John	sensory/automatic	tangible	undifferentiated	No
Doug-hitting self	attention	sensory/automatic	not tested[28]	N/A
Doug - hitting others	attention	tangible (class)	tangible	Yes
		escape (gym)	escape	Yes
Ken	sensory/automatic	undifferentiated	no behavior	N/A
Lisa	"control" and "power"[29]	attention	not tested[30]	N/A
Sam	attention	attention	attention	Yes
			demand	Extra[31]
Richard	escape/demand	demand		No
		attention	attention	Yes
Drew	sensory	demand		No
			attention	Extra
		tangible	tangible	Yes

Another goal of this research was to establish the likely success of an individual teacher being able to conduct simultaneous FBA data collection, further multiplying the time-savings for conducting FBA's in a school environment. To answer this question, we considered the success of the assessments, the efficiency of data collection, and the workload perceived by the teachers. Unanimously, the teachers reported that assessing

[28] Partially through the study, this function was determined to be of less interest to the teacher than the hitting of others. Thus, although she recorded a function for her data, we did not test that function clinically.

[29] Words like "control" and "power" would be classified as attention or possibly tangible by FBA specialists, but the teacher was adamant that it was these words in particular.

[30] This student passed away during the study. Thus, we were unable to complete a clinical validation of the hypothesized function. Previous assessments conducted at the school however, indicate the attention was a function of Lisa's behavior.

[31] "Extra" denotes functions that were uncovered during the clinical functional analysis process and thus were "extra" functions in addition to those hypothesized by the teachers.

multiple children simultaneously with the traditional method would be extremely difficult if not impossible but that the same assessment with CareLog would be highly possible. When asked about the possibility of doing this type of assessment with CareLog, one teacher responded, “yes, definitely, I think that would definitely be cool” and has since requested to use the system for a full year assessing each of four students in her classroom simultaneously. A simple modification in which each individual button on the remote triggers recording of an incident associated with a particular student enables this feature.

5.2.4 Perceived Workload and Difficulty of FBA and CareLog

FBAs, although valuable, are often not used in classroom settings because the workload on the part of the teacher (and sometimes the teacher’s aids) is simply too high to maintain good records regularly, do the analysis, and perform at a high level in terms of instruction and classroom management. Thus, one of the primary goals of this effort was to demonstrate improvement in the workload of the staff members involved in the FBA process. Use of CareLog substantially improved workload both directly in terms of their perceived load and indirectly in terms of redistribution of work in terms of time and staff.

Workload is a multi-dimensional psychological construct measuring the subjective experience of work that results from the mental actions performed while perceiving and processing information and executing a response. The NASA-TLX measures workload on 6 different dimensions (Mental Demands, Physical Demands, Temporal Demands, Own Performance, Effort, Frustration) to create a picture of the amount and type of mental workload a user experiences during task performance (Hart and Staveland, 1988). Use of these sub-scales allows different tasks to be compared for overall complexity for a human, in this case a teacher, to complete. We used it to understand the workload differences between the pen and paper case and the new experimental case of using CareLog to conduct FBA's.

Although the NASA-TLX is most commonly used to compare tasks that are exactly the same, I adapted the instrument to compare similar tasks. This adaptation was required because in each condition, the teachers were conducting assessments of different children. Furthermore, I have adapted the scales in the way in which the data was collected. Each teacher was asked to rate the workload of information capture at the end of each day, rather than immediately after each data collection moment. This adaptation ensured that teachers were able to complete the rating without significantly disrupting their work. Of course, the compromise to this adaptation is that ratings were more temporally distant from the activities, and we potentially lost nuances that might exist between one instance and another as opposed to a rating over an entire day.

The teachers completed forms for the basic incident capture (BI) portion of the process each day that they attempted to record data. In the CareLog case, this process includes starting up the system in the morning, clicking the button throughout the day, and potentially checking the interface to ensure data are being captured. They completed similar forms for the labeling of the Antecedents, Behaviors, and Consequences (ABC) for each day that they attempted to record this type of data. In the CareLog case, these activities were clearly separate given the labeling of videos recorded using a different method. In the Pen and Paper treatment, however, the ABC portion of the task is intertwined with recording of BI data. Thus, some confusion was observed. Finally, the teachers completed a third similar form for determining the function on the day(s) they performed this task. In both cases, this activity is clearly separate from the data gathering and labeling tasks.

Teachers completed as few as one or as many as twenty-two rating forms for any given activity depending on the number of days they performed the activity and their own compliance rates with the experimental protocol. All of the calculations were normalized for a standard 100 point scale regardless of the number of rating forms completed per teacher per activity.

When the workloads for all teachers were included, reduction was observed in the basic capture and determining function portions of the process. One outlier teacher did not complete the paperwork properly in some cases, and so it was impossible to determine the appropriate values for the labeling portion of the process (ABC) for that teacher. When this outlier was removed from the analysis, reduction was observed for all three portions of the process, although the reduction in the labeling portion is extremely likely to be due simply to chance, and the reduction observed in the function determination portion of the process (DF) was also not significant (see Appendix F.2 for details of the statistical significance of each measure). The minimal reduction in the labeling process is not surprising given that in the technology enhanced case, this portion of the process requires watching extensive video clips and making determinations about what is happening during those clips. Despite the potential concerns about this task creating an overly laborious activity within the FBA, the teachers did not report that perception. In interviews, they commented that the extra work of viewing the videos was acceptable, because they could do it on their timeline. Also when asked to rate CareLog in a questionnaire, they tended to agree that it was easy to use, that they enjoyed it, and that it was not time consuming[32] (see Table 12).

Table 12: Teachers were asked to rate their levels of agreement with statements about CareLog after using it for an assessment. The scale ranged from 1 (strongly disagree) to 5 (strongly agree).

Statement	μ	σ
CareLog was easy to use	4.50	0.58
CareLog was time consuming to use	2.75	0.96
I enjoyed using CareLog	4.25	0.50
The graphs in CareLog helped me to diagnose the function	3.88	0.63
Access to the videos in CareLog helped me to diagnose the function	4.75	0.50
Access to the details of a particular incident in CareLog helped me to diagnose the function	4.25	0.50

Overall workload as assessed by the teachers each day was reduced on average for all three portions of the FBA process: taking basic incident data (*i.e.,* noting that something happened), labeling the data with antecedents and consequences, and determining the function using the data (see Appendix F for details of the workload as measured within each of the six subscales). These reductions in workload can be attributed to a variety of factors, many of which were reported directly by participants. First, the software itself inherently provides benefits such as automatic organization of information and graphing of data.

Second, work could be redistributed to times more convenient for the teachers. That is, they could do the labeling of antecedents and consequences after the students had left for the day or over a weekend, as opposed to the requirement of labeling data during or immediately after the incident as with pen and paper. For example, one teacher noted

[32] One respondent to the time consuming statement did rate the statement a 4-agree, commenting below that "watching the videos later was time consuming." During interviews, this teacher mentioned that she believed she had "procrastinated" too long, leaving other end of year paperwork and the CareLog study to the end.

“it was a lot easier to go back when I had time to go back and actually see exactly what was going on.”

Finally, the teachers were more likely to entrust other staff members to take data when they were out of the room than with the pen and paper method. For example, when asked about the possibility of having staff members take traditional data, one teacher responded

> *“I would want the consistency of somebody’s who’s been trained with an FBA to do the antecedents and the consequences. And that’s a big change, between that and the clicker.[remote actuator] The clicker I could trust with a total stranger, a complete sub, I would expect that they could handle ‘click something.’ … Click it … if you see this, click it. You know, if you just show them one example of the behavior, if they knew what they were clicking on, that was nice. That would be a definite benefit.”*

When responding to the survey question about ability to record everything wanted about an incident, in the pen and paper case, one teacher wrote “Parapros [teacher's aids] completing paperwork sometimes was ineffective.” No non-teacher classroom staff member consistently collected data for a teacher in the pen and paper condition. In the CareLog condition, however, three of the four teachers regularly asked an aid to record data. In one classroom, an aid was in fact the primary data collector.

5.2.5 Reduction in Time Required for FBA

The goal of reducing time spent reviewing and analyzing data could not be measured quantitatively with the data that we collected. Although I had originally planned to ask teacher participants to keep diaries regarding the amount of time they were spending doing the review and analysis, we determined fairly early in the study that the extra work of keeping the diary was too much to ask of the participants in addition to conducting the FBA's, participating in interviews, and completing daily and weekly surveys. As a rough measure of time spent capturing data about each student, I examined the number of days in the study for each student (see Table 13), comparing the two conditions and the order of their assessments (see Table 14). Given that some students simply demonstrate their problem behaviors more frequently, thereby necessarily reducing the number of days in the study to reach data saturation, I also examined the number of incidents recorded for each student for similar differences (see Table 15).

Table 13: Number of days in study for each subject. Days in study were calculated based on the number of days between start and stop dates of assessments minus any absences, early dismissals, or school breaks.

Subject	Dates in study	# Days in study	Condition	Order
Derrick (A-PP)	March 15 to March 24	7	PP	1
John (A-CL)	April 11 to April 21	9	CL	2
Ken (B-PP)	April 12, and then April 26 to May 19	17	PP	2
Doug (B-CL)	Feb 8 to March 7	20	CL	1
Lisa (D-PP)	March 6 to March 27	15.5	PP	1
Sam (D-CL)	May 1 to May 17	8	CL	2
Drew (E-PP)	April 27 to May 16	14	PP	2
Richard (E-CL)	March 13 to April 19	18.5	CL	1
		μ = 13.63, σ = 5.01		

Table 14: Two-tailed matched t-tests comparing the CareLog (CL) and Pen and Paper (PP) conditions as well as the ordering found no significant differences in the number of days actively participating in the study. If anything, the trends indicate that the ordering (and the impending end of the school year) may have had a larger effect than the condition.

	CareLog vs. Pen and Paper		1st vs. 2nd FBA	
Means	13.38	13.88	15.25	12
Standard deviations	4.42	6.25	5.81	4.24
p-value	0.87		0.2	

Table 15: Number of recorded incidents per room, grouped first by condition and then by order. Two-tailed, matched t-tests found no significant differences in the number of incidents recorded during the study. There does appear to be a trend, however, that more incidents may be recorded using CareLog than with the traditional pen and paper method. A minimal number of false positives were measured for each teacher (less than five each), and false positives are not considered a big problem by teachers nor behaviorists. Thus, they are not included in this analysis.

	Condition		Order	
Classroom	CareLog	Pen and Paper	1	2
A	64	32	32	64
B	33	17	33	17
D	35	32	32	35
E	17	15	17	15
Means	37.25	24	28.5	32.75
Standard Deviations	19.57	9.27	7.68	22.69
p-value	0.16		0.70	

From the interviews, I was able to determine, qualitatively the perceptions about time use held by the teachers. During the CareLog treatment, we expected review of videos to be done at the end of each day or throughout the day. One teacher demonstrated this behavior, but the other three all watched and labeled all of their videos in "marathon" sessions. One did all of the labeling on a single weekend day; one during two half days at school, leaving the para-professionals in the classroom in charge during that time; one used the videos over several days watching individual videos repeatedly. This last teacher is a self-described "perfectionist" and expressed concerns frequently that she would miss details if she did not continue reviewing this behavior, as noted in these comments about her continued use of the system after she had formed some initial hypotheses:

> *"'Cause every day I see something different, and its starting to make me wonder if there's lots and lots of different things going on…Which I think is probably the case, so I kind of want to narrow it down. … To try and figure out if there's a certain, like if hitting himself is completely different from hitting someone else, or if they're both related, so I want to get a little bit more data and then go through and just kind of go over all of it again."*

In the pen and paper case, teachers usually perform this labeling at the same time as basic incident recording. Thus, the work is distributed throughout the process. In terms of time spent in determining the function, the most time reported by the participants in the pen and paper case was simply in doing the mathematical calculations (*e.g.* percent of incidents with a particular antecedent). These calculations are performed automatically by CareLog. No other differences in the amount of time spent were reported by any participants.

5.2.6 Efficiency

One important aim of this study was to determine if the technology enhanced process would result in faster diagnoses, fewer missed incidents by the staff, and less time spent in data recording and analysis. As such, with the entire team, we set as goals a reduction in time for reviewing and analyzing data and a reduction in number of missed incidents for all students.

Use of CareLog resulted in a significant 32% reduction of errors in recording incidents ($p = 0.0025$, see Table 16 for further details). Reduction of errors was calculated from all day video recordings during at least two different days per assessment. An average of 17 hours 26 minutes (σ= 7 hours 41 minutes) or 21.5% of time in study (σ= 4.88%) was recorded for each student. The videos were then coded for behavioral incidents using operational definitions created by the research team with the teachers' operational definitions as bases for these final definitions (see Appendix G for operational definitions). At least two video coders worked on each student's recordings, and at least 80% agreement was obtained for data viewed by both coders (at least 20% of the data) in each case. Because each teacher conducted two assessments, a possibility existed that the improvement was due to which order the teacher conducted the assessments. Thus, I also tested for differences between the first and the second assessments. The data demonstrates an increase in the percentage of incidents in error between the first assessment group and the second, but this result was not close to significant (p=0.39). Lisa's behavior was so complicated that I was unable to achieve a reasonable level of agreement (> 80%) for any two data coders of three who all coded her data. Thus, the results reported here do not include her data. Furthermore, any t-tests run on these samples were unmatched due to this omission, but still two-tailed.

Table 16: The teachers in this study missed fewer incidents in the CareLog condition than in the Pen and Paper condition, in terms of percentage of overall incidents observed during the all day recordings. The data for each teacher listed first by condition and then by treatment order is listed in this table.

Classroom	Condition	CL	PP	Order	1	2
		% Missed			% Missed	
A		42.42	72.73		72.73	42.42
B		31.82	70.59		31.82	70.59
D		53.85				53.85
E		38.89	77.78		38.89	77.78
Means		41.75%	73.70%		47.81%	61.16%
Standard Deviations		0.09	0.03		0.22	0.16
p-value		0.0025			0.39	

5.2.7 Effects of CareLog on the Educational Environment

Teachers reported benefits of using CareLog to quality of life and educational experiences in the classroom. Teachers reported that use of the captured videos allowed them greater access to the activities in their classrooms, whether they be staff or student related. Use of these new technologies for documenting and analyzing behavior also has implications for outcomes-based special education and concepts of teaching as cultural transmission, as first indicated in Chapter Two.

5.2.7.1 Assessment of Teaching and Care Practices

During interviews, three of four teachers reported noticing their own teaching styles and behaviors or those of their staff members. One teacher noted that she could see how well her staff was "following the plan" in terms of behavior intervention and planned to praise them for activities while she was not present. Teachers also reported being more aware of their own mistakes while teaching. In the focus group studies described in Chapter 3, administrators commented on that classroom staff may be able to self-correct those actions that may in fact exacerbate inappropriate behavior when viewing captured videos, but this effect had not been a specific goal of the design. As described in Section 2.1.1 of this manuscript, George and Louise Spindler similarly used video to evoke reactions from teachers about their own performance. In this case, however, neither I nor other members of the research team reviewed videos with the teachers. They commented both in interviews and through the questionnaire responses that this ability to review data that they themselves captured and that no one else could access was both comfortable and helpful. These restrictions may have provided the safe environment needed to assess their own performance critically.

Table 17: Agreement levels of teachers with statements about control of data: Teachers were able to assess their own performance with CareLog in part because they were comfortable with the level of control present in both capture and access.

Statement	μ	σ
I feel comfortable using CareLog and its videos in my classroom	4.25	0.50
*I would use CareLog even if it didn't automatically throw away video that I didn't want to save**	2.25	0.96
*The video recording in CareLog makes me uncomfortable***	2.75	0.96
I am concerned about who has access to the video snippets I recorded using CareLog	3.25	0.50
I would like to know who looks at the video snippets I recorded with CareLog	3.5	0.58

* Two teachers wrote additional comments about this statement that are worth noting. One commented, "I absolutely would not, I think only what the teachers want recorded should be recorded at the discretion." The other commented, "time consuming" presumably noting that it would be time consuming to go through the data without the filtering that occurs with the selective archiving model.

**One teacher wrote an additional comment to this statement: "I didn't mind when I was clicking the button and could record what I wanted to, but having [the researcher] record the class all day was uncomfortable."

Teachers specifically commented that they were able to use CareLog to gather data even when they were not present. One noted that she believed she missed fewer incidents in her room because

> *"when if I leave if I do leave the room, if I'm just like going to get lunch or whatever, a lot of times, I'm not… well, I'm not gone longer than five minutes, so I can go, and if they [her staff] say 'oh he hit' or whatever, I can just press the button and know that it will be in that five minutes."*

Importantly, such accounts as can be retrieved from the system are just that, accounts, not reality. The teachers in this case (or outside consultants if they were to view data recorded by teachers) will only be able to assess what the actuator of the archiving chose to save. It could be argued, thus, that the results could be manipulated, intentionally or subconsciously, by the very coding scheme (choosing when to save and when not to save) employed (Goodwin, 1994).

Finally, teachers commented about the ability to see what other students were doing during those times that they are occupied with the students who were the targets of the assessments, as exemplified in the following interview excerpt:

> Teacher: *I also remember the other time I was out of the room, it was interesting to see what was going on with the other students. Because there was an incident that was not caught while the other incident was being dealt with…So it was very interesting to see who got away with what, you know, when …*
>
> Interviewer: *Because there was less staff…?*
>
> Teacher: *Right, exactly…Yeah, so and not intentionally, but …*
>
> Interviewer: *…they sort of know when you're looking and when you're not.*
>
> Teacher: *Yeah, exactly, so it was funny cause I had to watch it like three or four times, because I was like "Nuh-uh" (laughs) and then you know, I would rewind it and be like "Yeah, what a sneaky devil" (laughs)*

5.2.7.2 Physical Design of CareLog

As part of understanding the effects of CareLog on the entire classroom environment, I also explored the optimal camera placement and the optimal number of cameras required for teachers. Using ceiling mounted cameras turned out to be a successful choice and one that was likely essential to adoption of the technology in these classrooms. There was no evidence of students noticing the cameras at all in three of the classrooms. In fact, in many cases, I had to remind adults not assigned to the experimental rooms when the cameras were in place, because they too either did not notice them or forgot they were there. The computers, on the other hand, were commented on or pointed at by students in all three classrooms in which such activity is likely[33]. Obviously, in a commercial product, we would expect a smaller, more embedded version of this hardware. In all four classrooms, when I (or other researchers) were present to record, the students noticed and reacted to our presence. The larger camera used for this recording was a source of interest in three of the four classrooms even when a researcher was not with it.

Although formative designs indicated that multiple cameras was likely desirable, some people have hypothesized that the sheer quantities of data generated might be more than is needed when deployed in a school. All of the teacher participants, however, universally reported that having all four camera angles in their classrooms was key to their abilities to understand what was going on. They were able to switch between attending to the different angles being shown on the access interface as necessary after only a few attempts. The low level of video resolution provided was reported to be sufficient in all but one of the rooms. This room is usually less well lit than the other rooms, causing some slight viewing problems that would be easily remedied with minor adjustments to the video capture modules.

[33] The fourth classroom includes the students with the lowest levels of abilities. It is unlikely that they would be able to comment on changes they observed even if they noticed.

5.2.7.3 Education and Behavior Plans

All four teachers reported wanting additional reporting features included in the system. A large part of their work includes the development of and reporting about Individual Education Plans (IEPs), a part of outcomes-based education for special education as described in Chapter Two. Without the ability to export data or generate reports directly, they were forced to document their assessments in reports composed in Microsoft Word, absent graphs or other visual elements. Although I had considered reports in the initial designs, the constraints of completing the software in time for its deployment prohibited their implementation. I was not particularly concerned, because I knew I would have access to the graphs and other visual elements if their text-based reports were in some way unclear. Two of the teachers, however, proactively chose to include these reports in the official files for each student and wanted to include graphs to supplement the reports for the official record.

FBA data are intended to feed directly into the development and implementation of Behavior Intervention Plans (BIPs). Although this study did not last long enough to measure success of those plans, many educators also use FBA to do just that. One can document behavior in the classroom (or other environment) before and after a particular treatment plan is in place. In fact, the validation of Doug's behavior in gym was achieved using a similar process. The intervention that had been working was removed so that we could observe if his behavior returned to its high levels. We then replaces the intervention and measured that the incidences of the behavior did in fact go back down to low levels. Thus, as described in Chapter Two, to the extent that behavior intervention plans are a method of cultural transmission, CareLog can be considered a means for measuring and monitoring the transmission of rules and mores about appropriate behavior. Continued use of the system over time can thus provide interesting data about the particular culture of the school or possibly even the classroom using it.

CHAPTER 6

BUFFERWARE DEPLOYMENT AND EVALUATION

I deployed and evaluated BufferWare in a shared space in a research building at Georgia Tech for over a year. The study design was exploratory in nature, with the goal of the BufferWare project two-fold: (1) to begin to understand the ways selective archiving technologies might be perceived, used, and adopted outside of special education and (2) to provide a contrast class of experiences against which to measure the deployment of CareLog and selective archiving elsewhere. Anyone who typically used the space surrounding the BufferWare deployment or who was simply in the building was encouraged to participate in a variety of ways: using the service itself, completing anonymous surveys, and participating in interviews[34].

Participants were employees, students, and visitors to the Technology Square Research Building (TSRB) at Georgia Tech. This site was chosen for a variety of

[34] In addition to these explicit modes of participation, nearly every inhabitant of and visitor to the building was in some way a participant in the research. By avoiding the space entirely, for example, in an aggregate sense, people were participating, because I logged space usage. Thus, lack of use is still data that contributes to this research. There are significant ethical considerations in conducting such research given that the very act of opting out of the research (whether due to discomfort with the system or with the research or just coincidentally) still provides data for the research. In the end, I made the decision, along with help and advice from both institutional attorneys and the IRB, that the anonymous nature of this data collection provided such low risk that no further methods of opting out would be necessary. Furthermore, the research could not have been conducted with any additional safeguards in place, because the inevitable end conclusion of further safeguards would have included only installing the system in a space in which everyone who might encounter it would always be comfortable and choose to be a part of the research. It is impossible to test the boundaries of perceptions of risk to capture (and to research about capture) in such a setting, because the very people who object would not be included in the data set, and thus would not be heard.

reasons, the most significant being convenience and legal protection. Georgia Tech provided the institutional and legal guidance that indicated that such a space would be most acceptable to this type of research given the controlled access (by access card or sign in at a security desk), the minimal likelihood of minors being present, and the general "work" atmosphere that would most likely reduce the incidence of inappropriate behavior being video recorded using Georgia Tech resources.

Although these constraints were necessary to conduct this research project as part of Georgia Tech, choice of this site also included some sub-optimal features. The TSRB is primarily a computer science research building. Thus, the people who inhabit and visit it are much more highly educated than the average person. They are also more likely to know about and consider issues of information security, research ethics, and so on. These characteristics provided for a thoughtful and interesting group of people who contributed much to the discussions of selective archiving and capture. They, however, are not a representative sample of the general population, and thus, all results should be considered with this caveat.

A variety of measures were used in this study, including both subjective and objective measures and both qualitative and quantitative methods. In this Chapter, I describe the methods and results of this evaluation.

6.1 Experimental Description

Central to the evaluation of BufferWare was the ability to probe some essential issues regarding:

- the acceptability of a selective archiving application in this space,

- the ways in which installation of such a service might affect usage of and perceptions about that space, and
- the relationship of selective archiving as a solution to the original challenges to informal capture laid out in Chapter Three.

Some of these issues could be assessed through objective, quantitative data (*e..g.* space usage), while others required a mixed method approach to draw information out of people affected by the system, even those not in favor and not users. Furthermore, throughout the process I learned about many issues with the deployment of BufferWare that were tangential to the central research questions. Thus, I removed the system and reinstalled it, attempting to address some of those issues in the second deployment. The deployment study can be broken into four phases: pre-deployment of BufferWare (preBW), first deployment (BW1), second deployment (BW2), and post-deployment (postBW). Throughout this Chapter, I present results thematically in many cases as opposed to temporally. When necessary, however, I denote the phase from which the data originates using the abbreviations noted in this paragraph (preBW, BW1, BW2, postBW).

6.1.1 Pre-Deployment

The pre-deployment phase of the study occurred from March to August 2005. During this phase, I and another researcher logged the space manually using a semi-controlled sampling algorithm. That is, we attempted to walk into the third floor commons area every 15 minutes during working hours and write down both what was occurring in that space and in the space on the second floor. We took over 300 samples over the course of the six months. The sampling was less controlled and less frequent than we had planned, however. Thus, it was mostly useful for providing us a general sense of what goes on in the space and when it is typically used, and it was not as helpful in creating a quantitative baseline of space use. We observed a mix of individual and group interactions in the space including:

- Small meetings, both at the tables and at the clear boards
- Lunch, snack, or "coffee break" gatherings
- Individual reading and work sessions
- Individuals and groups standing near and looking out the windows
- Cell phone conversations
- Land line portable phone conversations
- Eavesdropping from one floor to another
- Group discussions that did not appear to be work related

Towards the end of this period of time, I posted notices alerting people to the fact that BufferWare would be installed soon. I also emailed the residents of the TSRB using the faculty, staff, and student mailing lists for TSRB. Finally, my thesis proposal that took place in August 2005 provided another forum for alerting people to the plan and to the space sampling that had been taking place. Somewhat to my surprise, other than one question at the proposal about the permissions to do such an experiment and the lengthy discussions with legal counsel and the IRB, no other objections were raised during this time period.

6.1.2 First Deployment

I deployed the first version of BufferWare between September 2005 and June 2006. BufferWare was installed by installing the software on a secured networked desktop

PC[35]. The interface to it was provided through a touchscreen that was mounted in a table-top similar to the ones already present in the space. The camera was also attached to the PC via both video cables and security cables. Finally the microphone was attached physically to the PC, tuned down to get a minimal amount of space, and hot glued to the tabletop. I placed a bright blue strip of tape along the carpet to denote the area being captured by video.

During this time, the software automatically logged any requests to save or to delete buffered data. It also logged any requests made to view a video through the downloadable java application. Any requests made either to list the available videos or to watch them through the web interface were logged separately. These logs begin in February of 2006 due to a mistake in the logging software that was not caught until that time. Beginning in April 2006, motion detectors were also installed to log activity in the space.

6.1.3 Second Deployment

After gathering survey and interview input from the first deployment of BufferWare, our research team uncovered a number of small issues that could easily be corrected. Thus, I deployed a second version of BufferWare during September and October of 2006. The physical hardware remained roughly the same, including the BufferWare system and the motion detectors. One change that occurred was to the size and type of touch screen. The model we had used initially, which had broken and ended the first deployment, was

[35] I had a network port and power supply added to the common area so that I could hardwire the BufferWare PC. I also physically chained it to the poles, the nearby table, and the railing to secure it from physical theft.

no longer manufactured. Thus, we used a slightly larger one that provided less than an inch more screen space and was otherwise a very similar form factor.

Software updates for the second version of BufferWare were mostly made to make it a more usable and efficient system. The buttons were all enlarged to accommodate those people who reported their fingers were too large for the input. A stylus was present, as in the first deployment, but fingers may be more natural as touch screen input. The buffer length was increased to one hour to accommodate those individuals who had commented that they wanted to save an entire meeting more easily. The resolution of the video captured was doubled to accommodate concerns about video quality and the inability to read what was written on the clearboards in view of the camera. The email notification sent to alert a person to a new buffer now also included a link with a "magic key" that allowed them to log in to just that video using that link. They still had to log into the overall system to view other archives, however, for security and privacy reasons. Finally, additional changes were made to the primary interface viewed most of the time to address some of the concerns about feedback and access to the video data:

- The viewing window demonstrating the camera's view was doubled in size to provide better feedback.
- An additional visualization was added to the delete button, such that when it was invoked, the button would show the countdown to the resumption of recording.
- An additional notice was placed on the primary screen to remind users that unless they explicitly send their clips to the researchers, we would not view the clips.

As in the first deployment, I sent emails to the lists meant to include all residents of the TSRB. I also posted new signs that were more colorful and intended to be less threatening. These signs were posted both in the BufferWare area as in the first deployment but also around the second and third floors of the building, near bathrooms, and so on. Two versions of the sign were posted: one that included the legal language required by Georgia Tech, as before, and one that listed some potential uses for BufferWare and the ways in which the second version had changed from the first.

6.2 Tools and Methods

A variety of tools and methods combined to assess the impact of BufferWare. I combined objective measures (*e.g.* sensed motion in the space) with subjective measures (*e.g.* surveys and interviews in which people described their use of the space) to understand the ways in which perceptions did or did not match with some measure of reality in the space. I also combined quantitative metrics with qualitative analysis of interview and open ended survey data to get a more complete picture of the results. In this section, I describe the methods used and the results they were meant to provide.

6.2.1 Automatically Logged Data

I used sensors and the BufferWare software itself to log unobtrusively information about interactions with or near BufferWare. I used two motion detectors to log the use of the space in view of the camera. Simple black tape attached to the detectors limited their scope of view to the ranges depicted in Figure 25. The motion detectors send a wireless RF signal for ON each time they sense motion in the space. The log associated with these motion detectors shows the date and time stamp with a notation for each individual sensor firing. Because the logs are associated with the sensor sending a signal, not with specific time intervals, the data was smoothed before running statistical tests (*e.g,.* if a one minute interval smoothing was applied, a sensor firing at 10:12:05 and at 10:12:23 would only give one "ON" value to the one minute between 10:12 and 10:13.).

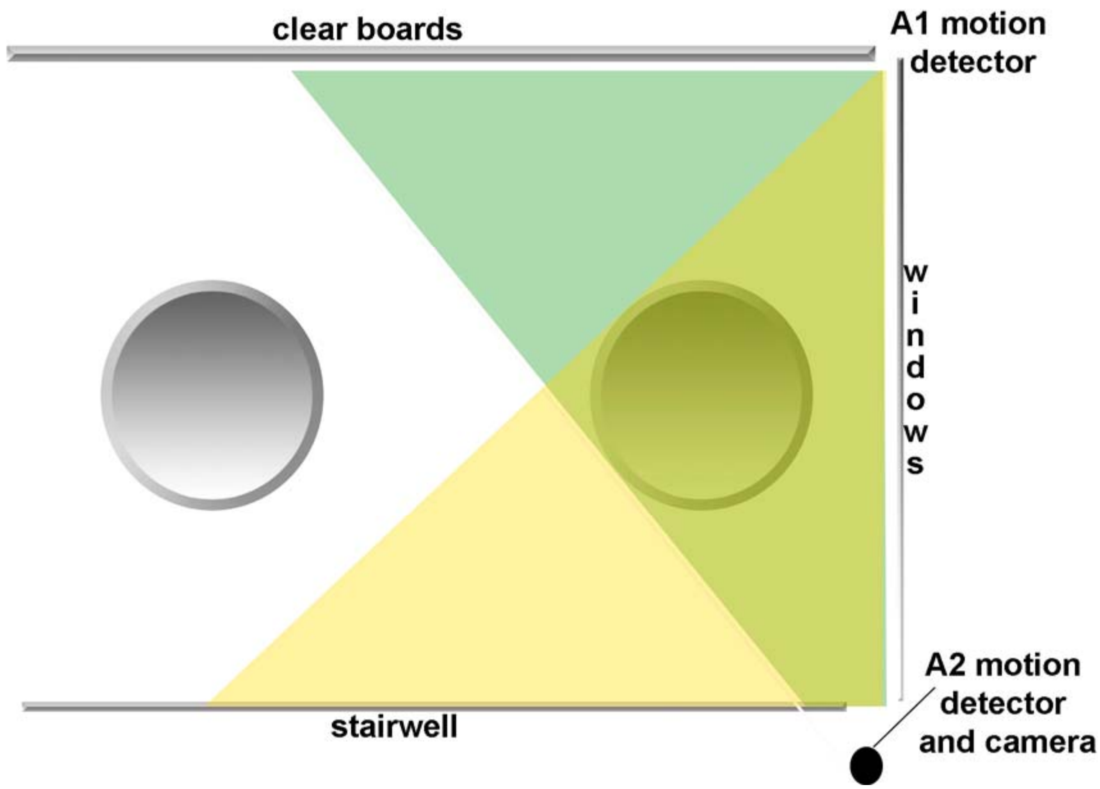


Figure 25: Birds-eye view of the BufferWare space. The orange shaded area near that stairwell is tracked by the A1 motion detector (as denoted in motion graphs in other parts of this Chapter). The A2 motion detector covers the same area as the camera view and is denoted using green shading. The two motion detectors combine such that movement in the camera angle as well as near the table more specifically can be tracked. It should also be noted that people reported during interviews that they sometimes intentionally gestured in front of the motion detectors or intentionally sat very still so as not to trigger them. These individuals appear to have been in the minority, and the sheer volume of data captured should make up for these errors. One day, the A1 sensor was turned outwards facing the traffic. Another researcher returned it to its typical position, and no similar incident occurred again.

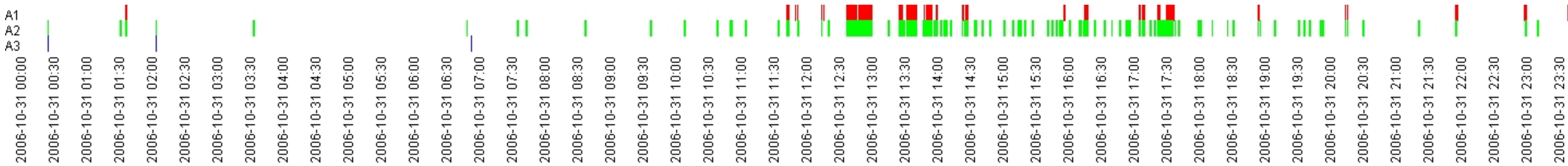


Figure 26: Wednesday November 1, 2006

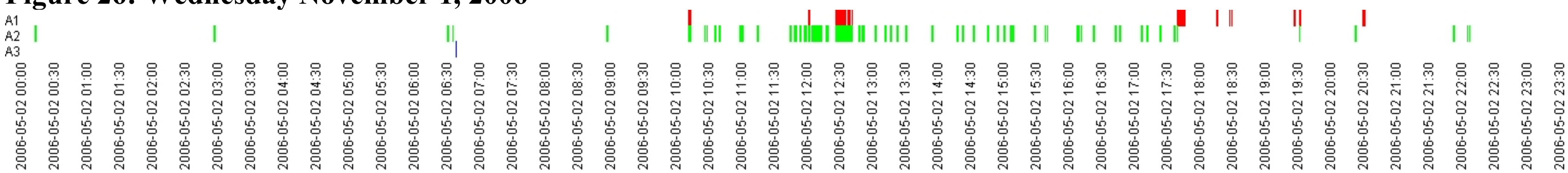


Figure 27: Wednesday May 3, 2006

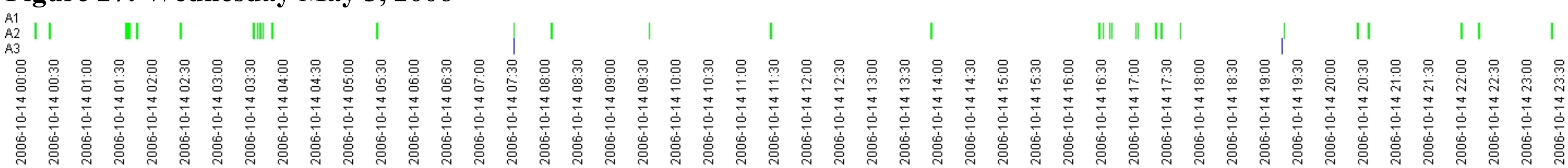


Figure 28: Sunday October 15, 2006

Visualizations of the motion detector sensor firings. A1 and A2 correspond to the areas demonstrated in Figure 25. A3 is an erroneous X10 signal included simply to demonstrate that minimal interference, if any, occurred from other X10 transmissions received by the logging software that simply logged every X10 signal received. These visualizations are not meant to be instructive in terms of changes between deployments and other results reported in Section 6.3. Rather, they are simply illustrative of the type of data logged. Two Wednesdays and a Sunday are stacked demonstrating the types of visual comparisons that can be made between days and the similarities and differences that can be observed visually. Other anomalies were also easily found with a quick visual scan (*e.g.* Thanksgiving, a major US holiday clearly had less activity than a typical Thursday).

I was also able to obtain a record of interactions with the software through automatic logging. Each time someone cleared the buffer or requested an archive to be saved is represented by a line in the log with a time and date and the action requested. Furthermore, beginning in February 2006, I also have a record of all attempts to list the archives saved to a particular account and all videos viewed. Finally, the database itself with a record of the archives it holds provides data about usage. I do not retrieve any actual videos, but I do query the database for records of how many videos area saved and by whom.

6.2.2 Surveys

At the end of each deployment period, I distributed a short survey throughout the TSRB. I placed a survey in each mailbox on the second and third floors of the building and scattered surveys throughout the common areas on both floors. The survey was completely anonymous but did include a space for name and contact information if the respondent was willing to participate in a further interview. Respondents could return the survey to a drop box located outside my lab on the third floor or to the mailboxes of the members of the research team. The second questionnaire included the questions from the first survey as well as additional questions comparing the two deployments and some that emerged from the first deployment. I distributed 100 surveys at the end of each deployment and received 19 completed surveys for the first phase and 13 for the second. These questionnaires are attached in Appendix I, and their results are discussed in Section 6.3 of this Chapter.

6.2.3 Interviews

Due to the potentially complex nature of decisions about control of data, participation in research experiments, capture in general, and other elements surrounding the BufferWare deployments, I also wanted to get in depth responses through semi-structured interviews. With the research conducted in HCI, and in particular at Georgia Tech, the goal is often to validate a particular design. In this case, I was not looking to validate a design. Instead, the primary goal was better understanding of the ways in which a particular technology might be perceived and considered for use. Despite this goal, people had mentioned casually to me that they had avoided talking to me about concerns for fear of offending me or the other researchers or other worries. Thus, it was important to find a way to get this information from people in a way in which they would be comfortable.

Three other graduate students, all practiced in interviewing, conducted the interviews after working with me to create the interview protocol and develop the recruiting scheme. They assured each participant that their comments would be made anonymous before being shared with the rest of the team. Each interviewer either transcribed or type copious notes about each interview and removed names and other identifiers when possible. In two cases, the participants noted that their responses would be necessarily identifiable and remarked that they were not concerned with such identification[36].

[36] In one case, the participant was a member of my research lab and had spoken extensively with me about the project. She also had used the system with me and with other members of the research team. In the other case, the participant had avoided speaking to me about the project for an extended period of time and had begun a conversation about it when she overheard me talking to someone else. Her description of that event was key to her statements about her understanding and thus needed to be included despite identifying her.

Ten people participated in interviews after the first deployment and seventeen after the second. Three individuals participated in both sets of interviews. Between deployments, the first round of interviews was minimally analyzed for basic trends and information that could feed into a better design for the second version. Both sets of interviews were then analyzed in more depth, both testing for hypotheses held prior to each deployment and using an inductive coding scheme to search for emergent themes. Some basic data about each participant was entered into a profile matrix to look for trends. All of the transcripts were also analyzed with both a deductive and inductive coding scheme. The deductive coding scheme targeted those questions we had prior to beginning the deployment of BufferWare, such as whether BufferWare's presence influenced use of the space. The inductive coding scheme was developed over a series of several iterations, using Grounded Theory (Glaser and Strauss, 1967), to explore such issues as the many and varied reasons for avoidance or use of the space, many of which could not have been predicted prior to the deployment of the system. The results of these interviews are described in Section 6.3 of this Chapter.

6.3 Evaluation Results

Data obtained through all of the evaluation methods was analyzed together to develop a complete picture of the response to the BufferWare system. Using all of this data, I was able to examine those issues considered prior to each deployment as well as examine some emergent themes. Furthermore, I was able to observe not only the ways in which people might perceive of and even fear capture technologies but also the ways in which they might adopt them and appropriate them for future uses. In this section, I present the results of this exploration.

6.3.1 Intentionally Explored Issues

At the start of the BufferWare project, I conceived of six issues that could be explored using the BufferWare installation. Early exploration during the first deployment gave rise to changes in my conceptions of these issues and their explorations in the second deployment. Through a long-term deployment of the technology in two phases with changes to the software itself and to the signs and other notifications in the space, I was able to examine:

- How deployment of BufferWare would affect both actual space use and perceptions about the space;
- How perceived value of recording affects the acceptability and adoption of this new technology;
- What factors affect the acceptability of BufferWare and what hurdles affected system use;
- The level of feedback and notification that is desirable for capture technologies, specifically audio and video; and
- The effects of the decision about saving a recording occurring after an event.

In this section, I describe the tools used to probe these questions and the results obtained with them.

6.3.1.1 Changes in Space Usage

Fundamentally, one of the major questions of this work is if and how installation of a selective archiving service would affect not only the perceptions of the technology and the space in which it is installed but also the actual use of that space. I tested the perceived use of the space through the survey data in which people were asked to rate their use of the table before BufferWare and during each deployment. I tested the actual use of the space using the automatic logging from motion detectors. Because the motion detectors send a signal at any time they perceive motion, which can be a somewhat random occurrence when people are in the space (*e.g.* sending one signal, another 10 seconds later, another 14 seconds later, and so on), I chose to smooth the data before running tests by dividing the day into segments of time. Once a quantity of time to be included in a segment was chosen (*e.g.* one minute), the data are parsed to determine if any movement occurred during that segment of time. Thus, if the motion detector fires three times in one minute and one time in another minute, both minutes will show motion and thus have a 1 recorded for them. I then used these large data sets[37] for analysis rather than the individual log items that can be less consistent.

[37] More than 30 days were logged per condition, and as many as 1440 segments per day were created when one minute segments were used.

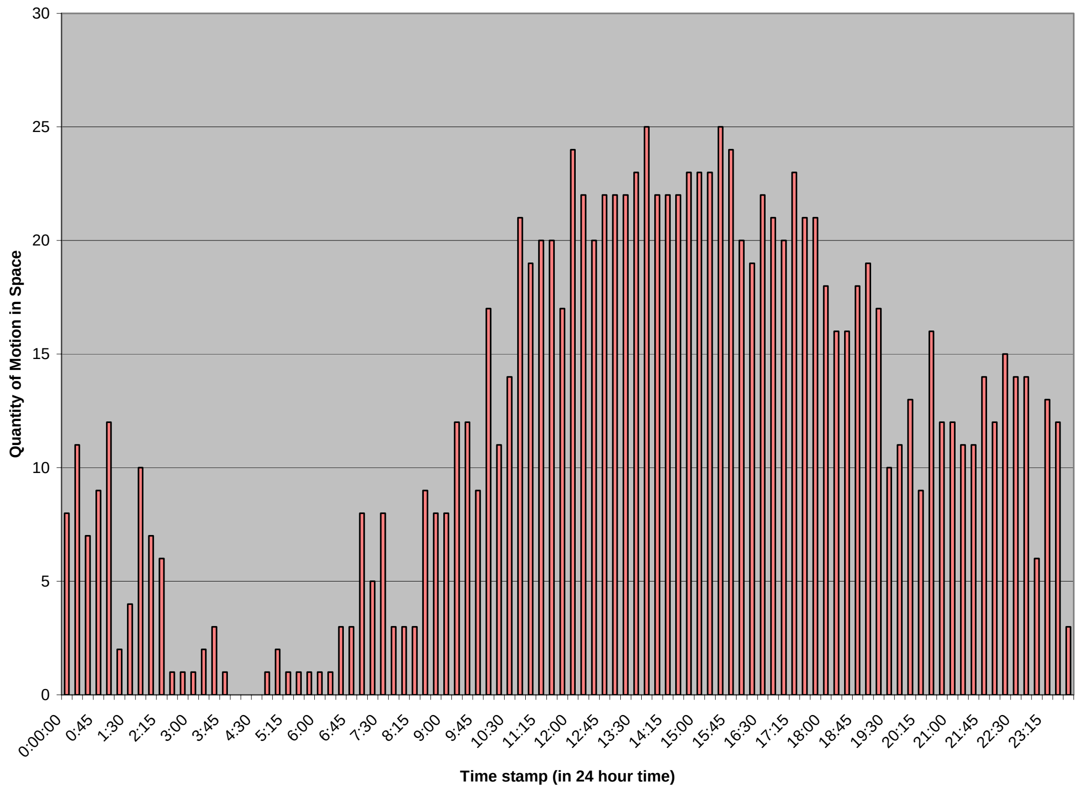


Figure 29: Sum of all motion in the BufferWare space during the Post-BufferWare condition. BW1 and BW2 conditions show similar trends.

Not surprisingly, patterns were easily detected in the data with regard to day of the week and time of day (see Figure 29). Overall, however, space use was perceived as low in all of the conditions (see Table 18) and was observed to be low across all conditions using the motion sensor data (see Tables 19 and 21).

Table 18: Reported time in BufferWare deployment space and surrounding areas from survey data. Details of a chi-square analysis are also included examining differences in the space use for the first three conditions of the experiment. N statistically significant differences were observed in the perceived space use as reported by survey respondents regarding the first three conditions.

Time spent in space ***rated from 1 (not at all) to 7 (every day)***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**μ**	**σ**
TSRB								5.66	1.18
Stairwell and common areas in general								1.81	0.96
BufferWare Area before BufferWare	14	8	6	2	0	0	0	1.86	0.99
BufferWare Area during 1st deployment	20	7	2	0	0	0	0	1.48	0.78
BufferWare Area during 2nd deployment	6	2	2	1	0	0	0	2.08	1.19
df = 6, Chi-square = 5.68, *p* <=1									

Some small, but significant, differences in the sensed motion data do exist between each of the conditions with space use during the second BufferWare deployment being the lowest, followed by use during the first deployment, and then post-deployment numbers being the highest[38] (see Tables 19-22). On average, people only use the space (with or without BufferWare) about a third of the time. Given that working hours are typically one third to a half of a weekday and a little less on Saturdays and a lot less on Sundays, this figure is not surprising. Furthermore, given the sheer volume of samples gathered using the motion sensing, it is also not surprising that a significant, albeit small, shift was observed. Some people reported changes in using the space that were coincidental, such as working more from home during one phase or another. Other people reported a variety of reasons for explicitly avoiding the space in both the survey and interview data. I describe some of these reasons in Section 6.3.2.

[38] Anecdotally, it may be important to note a few things about the use of the space. First, the BW1 data was captured at the end of the Spring semester in 2006, a time when major projects tend to be due in courses and group meetings are frequent. Also, during the post-BufferWare condition, I noticed that nearly every user of the space was also making use of the power supply installed in the wall near that space. That plug previously powered the installation and thus was not available for use.

Table 19: Descriptive statistics when data was smoothed for 15 minute segments. All days logged were parsed into 96 records (24*4 to divide the day into 15 minute segments) each containing a 1 or a 0. The first three sets of data tested are the averages of those segments across all days for each condition. The second three sets of data include the sum of these records across the first 30 days for each condition so that each condition could have a maximum sum of 30 and a minimum of 0.

	Mean	Std. Deviation	Std. Error Mean
BW1: Average per segment	.3649	.21940	.02239
BW2: Average per segment	.3592	.21892	.02234
Post-BW: Average per segment	.3856	.25050	.02557
BW1: Sum for particular segment	11.1771	6.93731	.70804
BW2: Sum for particular segment	10.3438	6.35913	.64903
Post-BW: Sum for particular segment	12.1771	7.89003	.80527

Table 20: Paired Two-Tailed t-tests for fifteen-minute segments. By creating and using these averages and sums, the t-tests comparing the means of these samples can be paired. The test is pairing the values from each time segment (*e.g.* 1:00:00 to 1:14:59) in one condition to the values from the same time segment in another condition. Three tests for averages are included and three for sums.

N=96		**Paired Differences**			**t**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**			
Pair 1	AVGBW1 - AVGBW2	.0057	.12210	.01246	.458	95	.648
Pair 2	AVGBW2 - AVGPOSTB	-.0264	.08945	.00913	-2.895	95	.005
Pair 3	AVGBW1 - AVGPOSTB	-.0207	.13099	.01337	-1.550	95	.124
Pair 4	SUMBW1 - SUMBW2	.8333	3.69257	.37687	2.211	95	.029
Pair 5	SUMBW2 - SUMPOSTB	-1.8333	2.87884	.29382	-6.240	95	.000
Pair 6	SUMBW1 - SUMPOSTB	-1.0000	4.21776	.43047	-2.323	95	.022

Table 21: Descriptive statistics when data was smoothed for 5 minute segments. All days logged were parsed into 288 records (24*12 to divide the day into 5 minute segments) each containing a 1 or a 0. The first three sets of data tested are the averages of those segments across all days for each condition. The second three sets of data include the sum of these records across the first 30 days for each condition so that each condition could have a maximum sum of 30 and a minimum of 0.

	Mean	Std. Deviation	Std. Error Mean
BW1: Average per segment	.1922	.14389	.00848
BW2: Average per segment	.1932	.14654	.00863
Post-BW: Average per segment	.2282	.18453	.01087
BW1: Sum for particular segment	6.0729	4.57057	.26932
BW2: Sum for particular segment	5.5417	4.26864	.25153
Post-BW: Sum for particular segment	7.1771	5.89099	.34713

Table 22: Paired Two-Tailed t-tests for five-minute segments. By creating and using these averages and sums, the t-tests comparing the means of these samples can be paired. The test is pairing the values from each time segment (e.g. 1:00:00 to 1:14:59) in one condition to the values from the same time segment in another condition. Three tests for averages are included and three for sums.

		Paired Differences			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean			
Pair 1	AVGBW1 - AVGBW2	-.0010	.09496	.00560	-.182	287	.856
Pair 2	AVGBW2 - AVGPOST	-.0350	.09342	.00550	-6.359	287	.000
Pair 3	AVGBW1 - AVGPOST	-.0360	.10329	.00609	-5.918	287	.000
Pair 4	SUMBW1 - SUMBW2	.5313	3.00390	.17701	3.001	287	.003
Pair 5	SUMBW2 - SUMPOST	-1.6354	3.21078	.18920	-8.644	287	.000
Pair 6	SUMBW1 - SUMPOST	-1.1042	3.40469	.20062	-5.504	287	.000

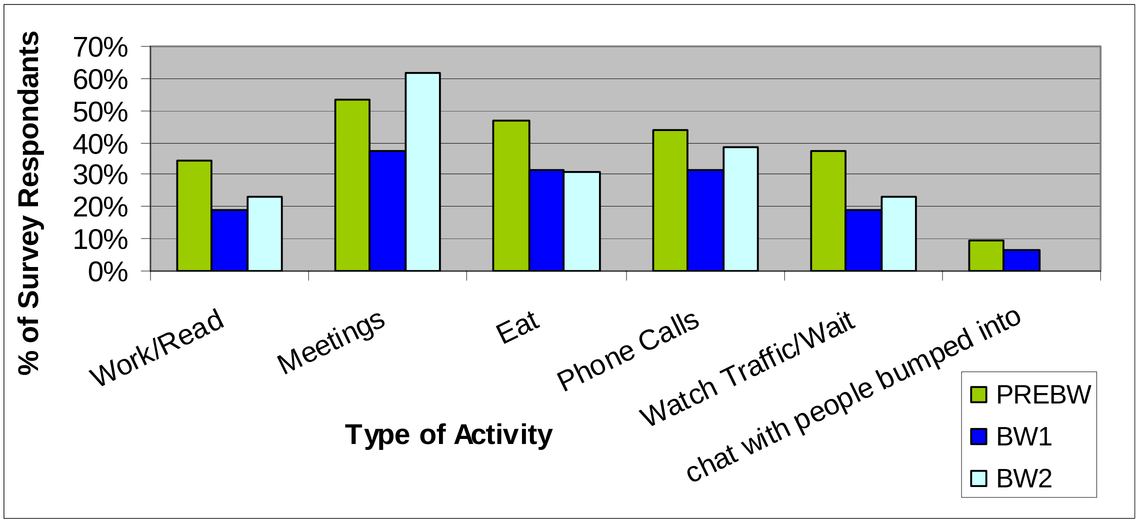


Figure 30: Reported activities in the BufferWare space. Each bar represents the percentage of survey respondents who noted engaging in each activity in the BufferWare space. Responses were logged from all 32 surveys about pre-BufferWare use (PREBW) and the first deployment (BW1), while only 13 responses included the second deployment questions (BW2). Thus, percentages of those numbers are shown here rather than summations that would necessarily make the pre-BufferWare and BufferWare One conditions higher simply due to sample size.

Table 23: Chi-square analysis of reported activities in the BufferWare space

Condition	work/ read	meetings	eat	phone calls	watch traffic/wait	chat
BufferWare Area before BufferWare	11	17	15	14	12	3
BufferWare Area during 1st deployment	6	12	10	10	6	2
BufferWare Area during 2nd deployment	3	8	4	5	3	0
df = 10, Chi-square = 2.48, p <=1						

In addition to the quantity of activity in the space as judged by both self-report and motion capture, my initial hypothesis was that installation of BufferWare might change the types of activities that occur in the space. General questions I received before the installation indicated that people might be concerned about breaking the equipment during activities such as eating and would instead reserve it for meetings. The ratios of the types of activities reported in the space, however, remained relatively constant even as the sum quantity of activity changed (see Figure 30). The one reported activity that showed a general trend upward during the second BufferWare deployment was use of the space for meetings. Given the relatively small sample size, however, it is unclear how stable this result is.

Using this mix of data, most particularly interview participants' descriptions of their choices in different situations to use or to avoid the BufferWare space, I was able to develop an Ethnographic Decision Model (EDM) (Gladwin, 1989) of the paths to three outcomes: use of the BufferWare space, use of an adjoining table on the same floor but outside the recorded space, or use of another space entirely (see Figure 31). Many of the points of decision in the EDM are revisited throughout this Chapter. Thus, in some ways it can serve as a roadmap of the evaluation results. The primary significance of this model, however, is to demonstrate the ways in which use (or avoidance) of BufferWare by a particular individual is heavily influenced by factors corollary to the selective archiving technology, such as respect for research and fear of interfering with research activities or disrupting research technologies and the preferences of others involved in a group activity with the decision maker. These issues suggest that future research in the areas of capture (and its acceptability) must use analytical lenses that account for the breadth of context and experiences that are relevant.

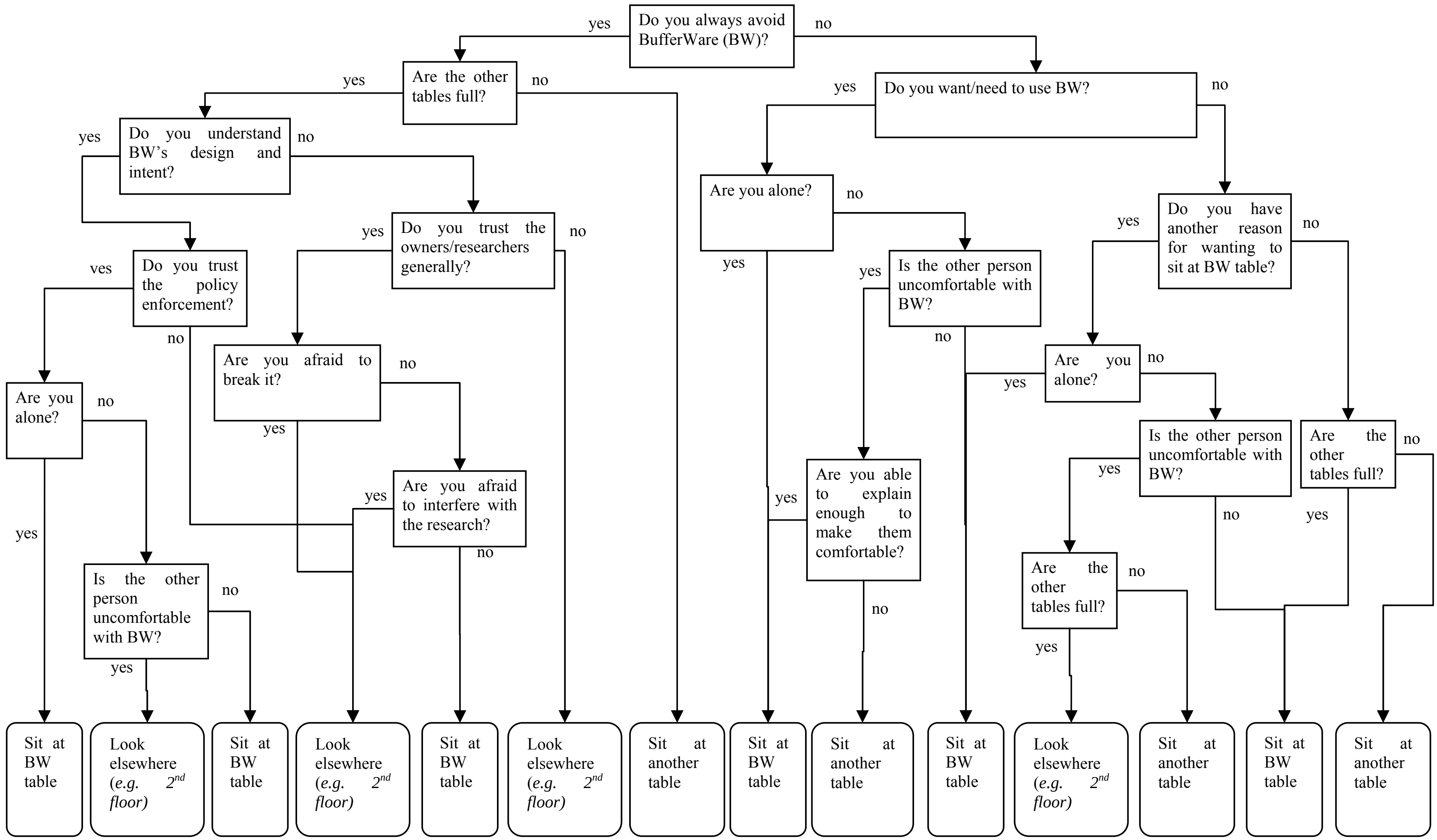


Figure 31: Ethnographic Decision Model regarding choice of use or avoidance of BufferWare space.

6.3.1.2 Correlations of the Perceived Value to Acceptability of Recording

In general, the interview data suggests that there is in fact a cost-benefit analysis either implicitly or explicitly conducted by individuals when they consider BufferWare or other systems of capture. The ways in which these perceptions are formed and in particular whether or not they find capture technologies acceptable, however, is a much more nuanced process overall for most of the respondents than simple cost-benefit for themselves.

People reported being willing to accept capture in most cases when there is a benefit to the community even if there is not a benefit to themselves. For example, when describing security cameras in comparison to BufferWare, people often commented that with security cameras, there was a greater good in protecting the general public, shop owners, and so on. Thus, they were willing to accept the risk to appearing on camera in those areas. Furthermore, in the case of security cameras, many people reported being willing to accept it, because they simply have no choice. With BufferWare, however, their use of it did not often correlate in their minds to a greater good and they could easily avoid the space and make a choice not to accept it. For example, one student interviewed noted:

> *Well, this is, I don't see any perceived benefit from being recorded. And, the security camera in the [College of Computing building], well they have to keep track of the building. You know you don't really have a choice in the matter. They can't really, it's not [a]*

> *smart enough camera that can recognize you but not record you. It's just… it just has to be done. I guess so [that's why] I'm accepting of it.*

When people did perceive a positive use for themselves personally, they were often willing to accept the capture more readily. In some cases, this perception could come from their own assessment of the technology, but in others, this perception was brought to them by peers. For example, one interview participant commented:

> *I had actually heard from other people that it was kind of cool, like they hadn't used it before and then they were having a meeting, and they actually had a reason to save something…so I had heard from other people like this idea that, oh well, it's actually useful for something, so... I wasn't quite so antsy about it at that point…*

In other cases, however, even people who perceived value to the recording were not comfortable with it. Some reported a general fear and uneasiness of both photographs and video of themselves, even those taken by friends and family or by security cameras, situations that ostensibly hold a higher value of use than BufferWare. Others were simply uneasy with BufferWare in particular regardless of perceived use. One participant who repeatedly expressed a general distaste for BufferWare and that she "wanted it to go away" also commented on its utility:

> *…now that I understand the project, I've started to say things like "gosh too bad we don't have a BufferWare here," while I'm talking to people because it would be great to have captured that most recent interaction we've just had or whatever.*

Finally, people reported being more willing to accept BufferWare, in part, because it was a research project. Although they often had even larger privacy concerns, often assuming that the researchers would view their video clips behind the scenes (further discussion in Section 6.4), they reported not breaking the equipment, disconnecting it, or otherwise expressing their discontent with the system out of respect for the research being conducted. In some cases, they even described not discussing their distaste for the project out of respect for other people's research or due to fear of offense. This sentiment was not the majority sentiment, however, as evidenced by several participants who reported having developed concerns only after hearing about them from other people or who had not used the space even when they wanted to use it on at least one occasion, because a companion expressed hesitation.

6.3.1.3 Acceptability of Selective Archiving as a Method of Capture

It was important to probe what parts of selective archiving in particular had effects on acceptability, as opposed to simply accepting or rejecting capture as a general concept. One challenge in this exploration, however, is that many people appeared not to understand the overall concepts or the specific details that would help them make informed decisions. For example, some people were not aware that they could delete the entire buffer and reported being much more comfortable with the system after learning about that feature. As another example, one person who reported being comfortable with security cameras because the video saved is recorded over so frequently (as in selective archiving), also noted being concerned about BufferWare:

In the abstract, video surveillance to me are ephemeral monitoring. They're not recorded… for me, it's because they are short term records it makes it ok… It's on a spectrum right? On one end everything is archived and on the other nothing is archived, and BufferWare sits somewhere in the middle. … I forget what it stores and what it doesn't store. I know it stores if you say so explicitly, but if you don't? I know that it's in the buffer system, but I don't know how often or how far back it deletes after a certain time.

Many people reported understanding the concepts of selective archiving but not necessarily trusting that the process described was actually being followed. For example:

So there's just a piece of paper on the wall that says "we're recording but we're not storing it." Well, how do you know? There's no way you can know it it's being stored for uh, later retrieval or not. And we're just supposed to trust some random piece of technology sitting there?

Even though multiple people suggested such issues, in some cases, they also commented that they wondered if they were alone in their apprehension. Concerns about trusting the enactment of policies sometimes were accompanied also by some concern by the participants that they appeared to be "irrational" or "paranoid." For example, one person noted:

I know from talking to [the researchers] that there's nobody watching it and nobody can tap into it. I know rationally what it

> *is, but there's just this feeling that, how do I really know? How do I know that somebody hasn't tapped into it?*

A survey respondent commented:

> *I know my answers sound paranoid. I don't think I really am. I don't actually think you'd do any of the things I've described. There's just this voice in my head that says "Beware the blue!"*

Another interview participant stated:

> *There's the rational part of my brain that says yeah, they're not actually doing anything with it. There's nothing nefarious going on. But then there's the paranoid part of my brain that says… wait, but they could be. How do I know they're not?*

These conflicting sentiments between what people inherently believe and feel versus what they logically can deduce indicate that there is much more to the issues of acceptability than just risk and reward analyses or other rule-based decision criteria. Furthermore, human instinct is both an important part of our decision-making processes and a complex phenomenon for which to design.

6.3.1.4 Hurdles to System Use

As noted in Chapter Two, designers of other systems for capture and access, particularly for informal settings, have often commented that the more hurdles to both capturing and accessing data, the less likely adoption was to occur, with the exceptions being times when the need for such capture is very high. The data collected during the BufferWare deployments reaffirm that higher hurdles make it less likely that people will capture and access data (*e.g.,* people commented in surveys and interviews that registration was a primary hurdle to using the system and that they didn't have enough need to overcome these types of hurdles). Furthermore, the perceived hurdles both to deleting buffered data and to finding information about the system also affected people's use of the space and the service and their perceptions of the same.

Ultimately, our design choices to make it as simple as possible to opt out of both the research being conducted and any possibility of being recorded made it so that simply avoiding the space was nearly always the easiest solution to any concerns. Many individuals made little or no effort to find out about the system and how it works, despite opportunities to do so. Avoiding the space was much easier than learning about the system. For example, when one participant was asked about ever considering requesting more information from any of the people involved, the response was:

> *Oh right, because it says "if you have any questions or concerns.." well, I don't have the time, whatever.. it wasn't that important to me.*

Many of the interview participants also commented about not knowing much about the security cameras in the TSRB and other locations. Given their assumed uses, however, information about these cameras may be less necessary. We, as designers, then should consider how much information people bring with them to their interactions with a captured space (*e.g.*, assumptions about the use and retention policies of the recordings) and educate and inform potential stakeholders in a quick, straightforward way, particularly when finding out about a service is not a high priority.

Another hurdle to system use was the constraints regarding access to the videos. Access to videos could initially be accomplished only by logging into the BufferWare access interface either through the java application or through the web. Furthermore, users could not provide access at a later date to other people. This feature was implemented to constrain the decision point of who could access videos to the time of saving, thus increasing the chances that anyone who might object to the sharing would be present at the time of the saving to voice an objection. After the first deployment phase, many users complained about the extra hurdle of having to log in, as opposed to viewing the video directly from an emailed link. Thus, we implemented a feature that would allow users to access the video directly from that link while still forcing them to log in to see the other videos they may have saved. There was an observed trend towards accessing the videos more with this design (see Table 24). Given the nuances of the amount of time deployed, the summative properties of continual ability to access videos captured early in the project during the last phases, whether or not new archives were being created at the time and so on, I did not run any statistical tests on this data.

Table 24: Number of times videos loaded with different archive notifications. People could continue to log in and access videos between deployments. They just could not capture any new videos.

Dates (in 2006)	Phase of BufferWare	# of times videos were loaded
February– Early May	first deployment	34
Late May – August	no capture available, still first deployment access interface	20
September – November	second deployment	54

A side effect of lowering this hurdle, importantly, is that users could now share the videos with other people simply by forwarding the link. Only one user reported using the email in this way, and no concerns about this change were voiced, but it remains a point of concern that should be considered in the future when designing such access policies and technologies.

A final hurdle of note to the use of the space surrounding BufferWare was in the deletion of buffered data. The design attempted to address this hurdle by automatically deleting any data that was not archived and was older than a certain amount of time. However, interview participants noted concerns about trusting the system to automatically delete. BufferWare also includes a feature wherein with one button press, users can manually delete all buffered data. Some people were not aware that they could also force a full deletion of the entire buffer. Some of those who were aware of the feature had not tried it and so were unsure of how difficult it was to accomplish. Still others reported concerns about remembering to delete before leaving the space. Whatever the reason, the perception amongst many of the interview participants was that deleting was too hard, or at least more difficult than simply avoiding the space. Thus, making it not only as easy as possible to delete information, but also designing systems and the spaces in which they reside to ease the burden on the user to learn about deletion and to remember to delete is an important challenge.

6.3.1.5 Notification and Feedback about Recording

Appropriate ways to notify people about recording and providing feedback about that recording are significant issues in capture research. In the BufferWare project, notification and feedback was intentionally plentiful. Specifically, the design of BufferWare included a visible camera with a small (although larger in the second deployment) window showing the live video capture feed embedded in a horizontal surface in the area. The signs, as previously mentioned, were abundant both in and outside the space and changed substantially between the first and second deployments. As with the other issues explored, interview and survey participants provided an abundance of information about notification and feedback, but many of their responses conflicted in some ways with each other.

People were divided in their outlooks on whether to make cameras visible or not. General distaste and discomfort with cameras provided some of the reasons reported for not liking BufferWare. For example, one person noted:

> *I don't like security cameras either, but I mean they're there usually for a reason, but they're also. They also tend to be more inconspicuous, so you don't even notice they're there.*

Some people commented that they tend to get nervous when someone is going to take a picture and would prefer that BufferWare's camera be hidden. For example, when asked about security cameras, one participant noted:

> *… that seems to bother me less because I'm not looking at the camera directly and sometimes, sometimes I'm not even aware that there's a camera there. So, when I notice the camera I get nervous.*

Similarly, the blue line used in the first deployment to notify people about the space being recorded likely brought many concerns about recording that might not have been present without it. For example:

> *I don't think that I necessarily notice the camera so much as I notice that big blue line… I think if there weren't the blue line, I*

would probably just, you know, avoid the table as opposed to the whole space.

We removed the blue line during the second deployment to combat some of these concerns. The camera, however, remained openly displayed both due to Institute constraints on the visibility of the system and the feedback from many participants that the camera being openly displayed was important for their comfort. When asked whether the placement of the camera bothered him in any way, one participant commented:

It doesn't, because I don't see a reflection of myself. It's not made obvious to me what the video captures… if there was a mirror of the video being captured…it presents a video surveillance feel or being monitored, but on the positive side it shows me what is captured…

In the same interview, this person also expressed concerns about the choice of the LCD and placement of it on a horizontal surface that was harder to view in some cases[39].

Maybe you need to have an LCD on the wall that's showing you "hey! This is what's being recorded right now!"

These quotes exemplify the conflicted responses we received when querying about camera placement and video feedback. People want to be able to make informed decisions about video capture, and part of that process is knowing what is being captured. On the other hand, however, constant feedback may create an aura of surveillance that is

[39] The choice of the LCD display being mounted horizontally rather than vertically was not a trivial one. I wanted to give feedback to indiiduals *in* the space without providing too much of that information to people walking by *outside* the space who could possibly see the display if it were placed vertically, for example on a nearby wall.

unnecessary and uncomfortable making people more self-conscious and concerned than they might have been with less feedback.

Another consideration was letting people know the default behavior of the system. Some confusion was introduced by the use of a demo version of BufferWare in the Aware Home. By default, the demo version was always "off" – not even buffering, much less archiving. This installation was only on when being actively demonstrated. On the other hand, the experimental deployment of BufferWare in the TSRB was by default on during operating hours. Thus, the major notification mechanism were the signs and a note on the clearboards in the space that said "BufferWare is recording in this space. For more information, please read the signs or visit carelog.org/bufferware." In reaction to this intentionally short, but perhaps too blunt notice, many people expressed concerns. For example, one participant described the discomfort with the system and signage as:

> *Wow! It's like BUFFERWARE IS RECORDING! It's like the big red "on air" sign at a radio station.*

Alternately, one person commented about being comfortable with security cameras primarily because notification is typically nearly as explicit and bright as an "on air" sign:

> *…they also give you besides the presence of camera that's very visible, there's also a red recording light or something like that…*

How best to notify people about recording was a significant challenge for the BufferWare system and one that continues to be a challenge for this and other capture systems. Because people differ so widely in their preferences about notification (*e.g.*, some want to be notified every time any recording is occurring while others would prefer to be notified the first time in a space that is typically recorded only while still others might prefer no notification at all), no "one size fits all" solution to notification is likely. On the other hand, tailoring notifications to particular people could in itself be perceived as a privacy-invading solution, because the capture system would have to recognize the individual to deliver a tailored message to that individual. When considering that preferences about feedback and notification may also include considerations of the context of activity, the problem grows and is certainly an interesting research area for the future.

6.3.1.6 Timing of Decision to Capture

People are very good at noticing important events but less skilled at predicting them. Thus, one of the fundamental aspects of the design of selective archiving is moving the decision to capture (or not) to after an event has occurred. Interview participants reported conflicting sentiments with regard to this choice. One person commented:

> *…it's not even when you enter a conversation that you're ahead of time thinking like, you're not filtering it in your head, 'ok this is going to be content that I want to be shared public versus private' when you start in on it, but it's the possibility of risk as you get involved with that activity – phone call or meeting – that you end up talking about stuff that are intended to be private*

At the same time, people often indicated understanding the rationale for moving the decision point to after an event even if they didn't necessarily feel comfortable with it:

> *I don't like the fact that the decision-making is after the fact and not before. I mean, I understand the rationale of how can you always predict when you want to capture something?… but…*

Similarly, Richter found that people often say unpredictable things even when they know, at least at some level, that they are being recorded (Richter, 2005). When our research group used TeamSpace for recording group meetings, sometimes just moments after recording had been announced and begun, people still made off-color remarks causing others in the group to remind them that TeamSpace was in fact recording. Being able to mark the past few minutes for deletion might have been helpful in those situations.

6.3.2 Emergent Themes

In addition to those issues explicitly probed with the BufferWare project, several themes began to emerge from the interview, survey, and log data. These themes include:

- Issues surrounding the ways in which institutional policies and constraints altered both the design of and perceptions about the technology;
- Management of "face" or self-image through capture technologies;
- Trust of people in general and of the specific policies and owners of the BufferWare project; and
- BufferWare as groupware.

In this section, I describe these themes and provide some considerations for future research in these areas.

6.3.2.1 Effects of Institutional Policies and Constraints

I had originally wanted to deploy BufferWare in a space that was not owned by Georgia Tech. After many discussions with both the IRB and attorneys at Georgia Tech, however, the concerns were too high about Georgia Tech being help responsible for content captured with publicly available audio and video capture, particularly as part of a research project. Thus, the site of a research building was chosen. Furthermore, concerns about potentially inappropriate uses of the technology led to the restriction of the availability of the service to "normal working hours," which at this site was considered to be 8AM to Midnight.

The process for notification about capture was also strongly influenced by institutional considerations. The wording presented on the initial signs to notify of recording, and the agreement at the time of archiving that indicates that other people nearby are comfortable with recording were prescribed by a legal representative for the Office of Sponsored Programs. During the first deployment, however, the signs were perceived as intimidating and scary. During the second deployment, the signs were swapped out with more colorful signs that stressed the potential uses and benefits of the technology. The required wording remained on the signs, however. Thus, even when the signs were made larger and more colorful, much of the intimidating language remained and may have continued to provide a gestalt sense of surveillance and danger.

Finally, I used the email distribution lists that are meant to include all people with offices in the TSRB as a means of communicating system status changes and other information. During the second deployment, however, interview and survey responses indicated that many people, particularly those who were newest to the TSRB and to Georgia Tech at the time they first encountered BufferWare simply did not know what was going on in the space. After some further probing, I learned that new students and students and faculty who had recently (within the past year) moved into the building had not yet been added to these email lists. Thus, they were missing many of the details they needed to understand the project and make informed decisions about it.

6.3.2.2 Management of Self-image and Face-work

Many of the concerns about BufferWare stemmed from considerations of self-image and of "face." I primarily use Goffman's definition of face in this discussion: Face is "the positive social value one effectively claims for himself by the line others assume that he has taken during a particular contact. Face is an image of self delineated in terms of approved social attributes" (Goffman, 1955). Two other definition are also useful to consider, however:

- Brown and Levinson define face as " the public self-image that every member wants to claim for himself" (Brown and Levinson, 1987)
- Ting-Toomey defines face as "the projected image of one's self in a relational situation." (Ting-Toomey, 1988) She also considers the ways in which face management differs cross-culturally, a point to which I return in this section.

In the case of BufferWare, the "approved social attributes" primarily coincide with what is perceived to be acceptable behavior in the American workplace. Given the nature of the TSRB as an academic research building, in which there are many hierarchical power structures (*e.g.* student and advisor, administrator and administrative assistant), it is useful also to consider the concerns raised in terms of their fit (and the fit of those raising them) within these structures. Concerns ranged from fear that an advisor might witness a student doing something that is not work-related to fear that "idle gossip" would be recorded and shared. Many of the concerns centered on the possibility that others might witness simple human activities that are generally considered impolite (*e.g.*, "scratching", "picking my nose", etc.) Some of these activities might also be associated with other elements of a personality that is undesirable or unattractive. For example, one person commented:

> *Well, I think sometimes I'll scratch my nose and it might look like I'm picking it or something. I don't want people to see that sometimes I bite my nails… sort of personal habits.*

People also commented that they often need a space for phone calls that are not work-related or that should not be shared with labmates. The space near the window in the hallway naturally affords such uses, because it is away from most labs and has relatively good mobile phone reception. Although not private, the space is separate from the other areas. Thus, people could use it as an area in which it was safe to project a different face than the one they typically use in the TSRB. The installation of BufferWare, however, interfered with this use for some people. For example, one person noted:

> *[On the phone, things I say might be] more personal than work related, and I work on keeping those realms separate.*

The possibility of recording in that space (and even more so, the possibility of researchers – members of the TSRB community – viewing those recordings) meant that it was no longer a separate area in which a different face could be projected. These comments exemplify the ways in which some concerns about BufferWare highlight issues of boundary management between home and work life (Nippert-Eng, 1996). A full consideration of the boundaries between home and work are not considered in this work but do merit further exploration when considering both information and communication technology use and recording technologies.

I included Ting-Toomey's definition of face, because her work focused on the ways in which different cultures might negotiate and care about face. She notes that in collectivist cultures (*e.g.,* Japanese), maintenance of other people's face, for example by avoiding embarrassing someone else, is more important than maintaining your own face. On the other hand, in individualistic cultures (*e.g.*, American), self-presentation and maintenance of individual face is much more important than the collective face. Most of the residents of the TSRB are American or from other individualistic cultures, although there is a strong Asian contingent. One of the Asian participants in the second set of interviews even noted that she believed the concerns about BufferWare were strongly American and that they would not come up in her country[40].

6.3.2.3 Trust of people and policies

Trust is an important and complex element when considering the ways in which people perceived the selective archiving technologies in BufferWare. Some of these concerns relate specifically to BufferWare, but others are more pervasive concerns about human nature that necessarily merged into concerns about BufferWare. For example, the following comments exemplify the types of concerns raised when a person expressed distrust not only with BufferWare, but with people more generally:

[40] These sentiments are paraphrased, because she made the comments just after the recording of the interview ended.

> *I wouldn't want to [save anything with BufferWare] because I don't know who's seeing it or where it's going. Even though they say it, I don't believe them… because I think it's just my belief in human fallibility. They can promise something, but delivering it is really another issue. I mean their intentions could be there, but you know…*

The issue of who owns and who controls the data came up repeatedly, with the people who expressed the most comfort with the system also indicating a lot of knowledge about and trust in who was in charge of the system (*e.g.,* commenting that they already had a strong relationship with the researchers).

Those people who did not necessarily know the researchers, often reported looking for indications of other trusted entities, such as Georgia Tech or the IRB. Although the system was housed on Georgia Tech servers with IRB approval, the domain name was cloaked to make it easier to type in and to remember, and not all of the signs denoted IRB approval. Furthermore, I used a non-Georgia Tech email address (bufferware@gmail.com) to receive comments to provide a level of indirection from me in the hopes that it might encourage more frank feedback. Ultimately, these design choices proved to be flawed, divorcing the system from trusted entities (me, Georgia Tech, etc.).

> *The domains are all non Georgia Tech, and there was no explanation of why…Do I have the protections of the Georgia Tech IRB policy and what not?.. when there's Georgia Tech saying, "this is not being recorded" we have a strong relationship as Georgia*

Tech students and employees, with the institution there is a certain amount of faith you can take in that.

Concerns about trust, about who owns and controls the data and access to it, and the ability and likelihood that the researchers would enact the policies as stated were fundamental to perceptions about BufferWare. Both in cases in which the interview participant trusted the researchers involved and in cases in which there was less trust, people commented that had they found the system in another location, they might have been more leery. One person also commented that retention policies are important and voiced concern both that one did not exist for BufferWare and that corporations can change these policies regularly and without warning. Thus, in this view, users of such technologies have little or no control over the long-term potential uses and abuses of their saved videos.

As a final point, use of multiple indicators about BufferWare warning people that recording might be taking place may have in fact had the opposite effect intended. So many warnings were put in place with the intent of providing people with the information they needed to make decisions. This intentional visibility was thought to enhance the possibility of trust between people who wanted to use the space and the researchers. These kinds of specific indicators and tools for protecting people, however, may have actually prevented potential users and the researchers from showing one another that could be trusted through other means, the reverse of which Erickson and Kellogg argue took place in their evaluation and deployment of the Babble chat system for both one-on-one and group communications (Erickson and Kellogg, 2000).

6.3.2.4 BufferWare as Groupware

BufferWare was designed to be flexible in terms of use by individuals or by groups of users as part of the exploration of potential emergent uses for selective archiving technologies. Interestingly, nearly every use of the system that was reported involved multiple people[41]. Furthermore, those people who reported viewing any archived video segments nearly universally reported viewing ones sent by other people more than those videos they themselves saved.

People used BufferWare to share information with one another. For example, people reported sending and receiving snippets of meetings that occurred in the BufferWare space and in which something was phrased in a particularly good way, and they wanted to save and to share that exact wording. For the most part, however, interview participants commented that these moments are few and far between and that current practices for documenting informal meetings, such as note-taking or photographing large shared writing surfaces, are sufficient.

People also reported going into the space intentionally to send messages:

> *We sent [our friend] a message because he was feeling bad, so we sent a 'we miss you' message.*

This same individual described having a trick played on her using BufferWare. Many people who were registered for the system would receive messages from people who were likely just testing out the system out of curiosity. She had been complaining about the receipt of such videos, because she would watch them assuming something was there

[41] The only individual uses reported were to record one side of a phone call as a memory aid and to record a practice presentation so that the individual could watch his own presentation.

for her to see only to find that she often did not know the people or that there was no interesting content. One of her friends then responded by sending her multiple blank videos.

> *I get these 15 minute videos and it's annoying because I go through and try to look through the video to see who it was and a lot of times, it's just nothing – it's like the table there. And so someone comes in, they go up to it, and then go away…I remember one time [my friend] sent me like ten million videos 'cause I was complaining about it. He did it to kind of spite me.*

Other people reported being very excited and then disappointed when these unknown video clips would show up in their accounts. For example,

> *I was always really excited to like see what this like foolish person sent to me, but it was always like a split second of I couldn't figure out who this person was…*

Whatever the reaction (annoyance or excitement), it is interesting to note that some people reported continuing to view the videos sent. The addition of a comment with the videos (*e.g.,* "Check out how Jane described that problem. It's exactly what we want to say."), a "from" field, and better control of access to potential recipients of videos might create a higher likelihood that people will view segments of interest and disregard the others.

Finally, many people either used the capture for activities related to fun and performance. As already mentioned, people used BufferWare to play pranks on one another. While waiting for me one day, my husband and a friend danced in front of the

BufferWare camera and saved the clip for me. I received the email about the clip the next day and was amused to find it in my saved archives. One interview participant commented while laughing:

> *…honestly I do wish I'd done like a little sock puppet show and sent it to everyone. Especially like [the researchers] – like "hey guys! I guess we're on video now".*

Use of video in particular naturally affords these types of "fun" activities. Further emphasis on them, as opposed to the perceived emphasis on informal meetings in the BufferWare project might contribute to a more entertaining atmosphere and increased adoption. Further research is required to know the extent to which these activities would in actuality influence perceptions and use.

CHAPTER 7

REFLECTIONS ON SELECTIVE ARCHIVING

At times, even in the most unstructured of natural daily activities, people need a record of what has occurred, and sometimes those records must be rich and filled with media other than text-based descriptions or notes. At the same time, a world of constant capture invokes Orwellian fears of surveillance and monitoring. Thus, the selective archiving model, in which data are constantly buffered but requires explicit input to be archived, was designed to be a compromise through which the conflicting requirements of control, privacy, and comfort could be balanced with the needs of people who require rich records of experiences. Through multiple formative studies and two deployment studies of selective archiving technologies in very different spaces for very different reasons, I am able to tease out some significant themes. In this chapter, I discuss those issues as observed in this work and outline some areas of future research in selective archiving. Furthermore, where applicable, I bring in a discussion of the Personal Audio Loop (PAL) project, which included buffering technologies but not archiving. Furthermore, it was a personal on-body system, whereas CareLog and BufferWare were both environmental. Some distinct and important features of these technologies are best understood when compared with one another.

7.1 Ownership of Data

Issues surrounding who owns the data captured were plentiful throughout the CareLog, BufferWare, and PAL projects. Furthermore, ownership of the recording equipment itself can signal ownership of the data in some cases. Knowing who owns and controls the data allows people the use of other methods of negotiation outside of the technology itself (*e.g.,* talking to the owner about what is saved and requesting the stopping of recording, etc.).

Typically, in schools, when teachers take FBA data, they are asked to do so by someone else. They often then turn those records over to the asking party for analysis. In the CareLog deployment, teachers were doing their own analysis in both the pen and paper and technology augmented conditions. They frequently commented about the value of FBA in both conditions that they had previously not seen, because they were merely the data collectors.

When discussing the videos that were saved with CareLog, similar sentiments were expressed. Teachers commented that they were very comfortable, because they were in control of the capture. They also knew where the data resided (on a non-networked set of PC's in their classrooms). Even though they did not own these machines, they believed they belonged to them temporarily and treated the data as their own. They were the only ones who would access the data for analysis purposes, and they could delete any video segment they had archived at any time. In essence, they could keep control of the data from the beginning to the end of its lifecycle. There was no question that the data belonged to the teacher in charge of the classroom.

The non-teacher staff also appeared to recognize that the teacher owned the data collected with CareLog, and that could sometimes be a tension. Staff members would sometimes ask the teacher in the middle of an incident if she had clicked the button to invoke capture. At other times, both teachers and staff made comments that the teacher could request a clip upon walking back in the room after a short break and therefore observe activities that happened while away. In terms of problem solving about student behavior, this functionality is crucial to teachers being able to diagnose events when they are not present. In terms of staff perception, however, a very powerful tool was given to the teachers who are already managers of the entire classroom experience.

The potential concerns were typically resolved in several ways. Teachers often discussed the goals of the project and what was recorded with their staff. I regularly assured everyone involved – teachers and staff – that the records would only be used for the diagnosis and for my research and would not be shared with the principal or other administrative body. Teachers were also more comfortable bringing staff into the recording process when using CareLog than when using the pen and paper method. Thus, staff members were also sometimes given control of archiving, likely empowering them within the classroom and the FBA process and making them more comfortable with the video recording.

Finally, outside of videos captured with CareLog, our research team was recording video all day at least 20% of the time that any student was enrolled in the study to establish a baseline for the behavior. During these times, a graduate student (often me) followed the individual student with a handheld video camera, in the classroom, through transitions, and in other spaces. One teacher expressed concern about portrayal in those videos after a particularly rough set of behavioral incidents. The concern largely resided in an open question about who owned that video data and for what it might ever be used. This same teacher commented on the end of study survey that the overhead cameras from CareLog were not a concern, but the all day recording was uncomfortable.

Similarly in the case of PAL, one person is often perceived very clearly to own the data recorded. In that case, physical ownership of the mobile phone is the primary indicator of who has access to the data. Although it is possible to copy and save, it is difficult, because of the inherent properties of the software that do not allow easily for archival. Thus, the primary recourse for getting someone to delete or not use the data is social negotiation with the holder of the technology. Much like in the CareLog case, because it is known who controls, owns, and has access immediately to the data, people expressed that in cases in which the saving was particularly problematic, they would make use of their social tools to change the behavior (or likely the relationship would be severely damaged by a refusal).

In the BufferWare deployment, ownership of the data was much less clear. In fact, we had established no real policy about it. Loosely put, my plan was to keep the data available as long as possible for the registered users, ending access and destroying it when I could no longer maintain access to it, emailing them when I was going to destroy it, and allowing them to keep the data themselves as allowed by Institute policy. Most of this information was never made public in any usable way, such as in a retention and use policy.

Once data was saved, it was saved to a particular account (or accounts). Thus, in my design, I intended the data to be owned by the particular account holders, to be saved, reviewed, or deleted at will. However, little was published (and thus little was known) about where the actual server with the data resided. In fact, the data was split across to servers, both of which were in close proximity to the BufferWare space, but few people had this information. Thus, people often questioned where the data might be stored, who physically, legally, and logically owned it, and therefore, what might be done with it.

I used the signs in the space and the emails to pass some information on about data ownership as the concerns began to surface. However, as described in depth in Chapter 6, these methods failed for a variety of reasons, not the least of which was the email distribution lists did not include new residents of the TSRB. Furthermore, as new people moved into the TSRB who did not know most of our research team, even if they were able to associate ownership of the system to a person, they might not have had the social recourses typically available when the data owner is well known to negotiate recording.

Perceptions about ownership of data can be complex and nuanced and are central to the acceptability of capture technologies. As researchers and designers in this area, it is crucial to understand three features of systems that might affect these perceptions:

- Physical indicators of data ownership, such as placement and physical access to the servers on which the data resides;
- Ability to capture, to delete, and to access the data (anyone who can do all three is often perceived to be an owner of the data);
- Access to social processes by which to negotiate with the data owner (and the power relationships such as in schools or a place of business that could prevent such processes).

7.2 Choice

Another important aspect of selective archiving, and capture technologies in general, is the presentation of a choice to opt in or out of a capture system. It is easy to argue that choice should be maximized in these cases, and indeed, the technologies and studies for CareLog and BufferWare were designed to maximize choice for involved stakeholders. Despite these design choices, however, perception about choice was mixed, and when considered alongside other capture systems such as PAL, surveillance cameras, and wide range CCTV initiatives, issues of how much choice to support become more complex.

In the CareLog deployment, once a teacher had decided to enroll in the study, the entire classroom was enrolled unless someone objected. In one case, a teacher's aid strongly objected. He expressed that he had a "phobia" of recording and would get nervous and freeze when snapshots and videos were taken at social gatherings. He was moved to another position in the school that did not involve the study, and in fact, everyone involved was happier in the end with the traded jobs. The effort was not small, however, and involved the principal and changing of daily activities. Thus, one can easily imagine that other people may have been concerned but not enough to go through that work and thus chose to remain in the recorded classrooms.

Once the choice was made to remain working in an enrolled classroom, people present had very little choice about being captured or not. The cameras for CareLog covered the entire room, and when a researcher was present another handheld camera was used to follow the student of interest. One staff member physically avoided the handheld camera as much as possible, always choosing to work one-on-one with students other than the one being recorded. This staff member, however, could not avoid the overhead cameras that were part of CareLog and expressed comfort with them despite the discomfort with the handheld camera. After further probing of this issue, this staff member described multiple potential reasons for increased comfort, including lesser visibility of that recording and a different view from overhead rather than from face on, but in the end, she was unable to supply a concrete reason for the differences in her perceptions. I hypothesize that people may actually have higher levels of comfort with those technologies that they have little choice about avoiding, a point that needs more inquiry and to which I return later in this section.

In the BufferWare deployment, the choice to be in the study or not and the choice to be recorded or not were both made readily available at each and every interaction with the system and the space. Some people still expressed negative sentiments about not having a choice about the installation of the system more generally, but all those who objected also commented that they could easily choose to go elsewhere or not use the space. People commented that simply avoiding the space was nearly always the easiest choice over gathering more information, trusting the system, pressing delete, or unplugging or covering the recording equipment.

In this situation in which it is easy to choose to avoid capture, people freely described the ways in which they would avoid it. When asked in the same interviews, however, about surveillance cameras, very different reactions were voiced. Even if those people who commented that surveillance cameras were there for safety and therefore in a different class are discounted, there are still examples of people for whom BufferWare is a concern and surveillance cameras less so. When probed further, the reasoning often came down to the lack of choice. Essentially, because they have to accept some amount of recording to drive on the highways in Atlanta, use the bank or grocery store, and enter the TSRB building, they do. Interestingly, the one staff member in the CareLog study with a self-described "phobia" of cameras described to me the elaborate ends to which he goes when using such spaces, including mapping out the optimal path in a store before entering so that he could enter with his head down and move quickly through the space, remaining on camera the minimal amount of time possible. Even this individual found ways to tolerate recording when necessary. Thus, any risk and reward models most account for not only the potential risks and rewards of technology use or avoidance but also of the entire setting (*e.g.,* being employed in a surveilled space, buying groceries, etc.).

7.3 Visibility and Awareness of Recording, Archival, and Deletion

The effects of the visibility of recording can not be underestimated in understanding the ways in which capture technologies are perceived. In terms of selective archiving in particular, visibility not only of recording but also of archival and deletion may also affect acceptability and adoption of these technologies.

As described in Chapter Four, CareLog was designed to have minimal environmental impact so that the students would not be distracted or concerns about the system's installation. At the same time, this design choice also meant that teachers and other staff had minimal visibility of the actual recording equipment which was mounted discretely to the ceiling. The teacher held substantial visibility into the archival and deletion processes by controlling both the remote that actuated archival and the access software through which deletion is possible. Minimal feedback was supplied to the teacher and staff members about when an event is saved. As shown in Chapter Four, a small window indicates that an event was saved. Teachers did use this feedback occasionally to check that they had successfully archived some data, but often they were too busy with the incident to check. No feedback about the camera angle was provided during capture, because the entire room was blanketed with fixed cameras. Such feedback might have been helpful, however, because occasionally a camera would fall or stop working, and often the staff would not notice until they went to view data later.

The staff members other than teachers had little knowledge, unless they asked the teachers directly, of what was archived or deleted. For the protection of the equipment and due to space constraints, all of the teachers had asked to have the monitor on which the feedback window was displayed, placed behind their desks. Thus, this information was relatively inaccessible to most staff members. All of the staff members were briefed extensively about the automatic deletion capabilities inherent to selective archiving, but they had little visibility into whether or not a teacher saved data. Teachers and staff alike frequently commented that the all day recording was distracting to them or caused them to be uncomfortable due to heightened awareness of the capture over the CareLog installation.

In the BufferWare deployment, visibility and awareness where highly varied across the stakeholders involved. The camera used was a high-end pan-tilt-zoom web cam mounted nearby that looked quite obviously like a camera (as opposed to security cameras that are often more concealed). People who used the space quickly and easily identified it. People who had not used the space during the deployment, however, could not easily see it, due to its mounting between two structural elements of the stairwell that block most views of it from outside the space.

Feedback about what is being captured within the camera's angle was also shared only with people in the space. This feedback was presented through a small video window on the embedded touch-screen that could be used to control the system. Again, to access this feedback, a person would have to be in the space. Thus, visibility for concerned parties who chose not to be in the space was minimal, a point that caused some unease for some of these people. Furthermore, there was nearly no visibility in the space or otherwise, provided abut the microphone's range and status. One person suggested after the first deployment to create a visualization of the captured sound waves that could be mounted vertically nearby. In this way, people outside the space could easily glance to see if they might have been recorded. Likewise, people inside the space intending to record, who often complained about the quality of audio (which had been intentionally reduced to avoid accidental recording of people outside the space) could ensure that what they wanted captured was indeed saved.

The open visibility of the camera in the BufferWare space, was generally considered to be a positive design choice. People expressed that they would not have liked to find out later that there was a camera in place and that seeing it and the LCD display helped them make decisions about the capture. At the same time, however, some people noted that they would likely have been less concerned about the capture were the camera not quite so apparent. People expressed a conflict between wanting to be aware of the capture and wanting the camera itself to be less visible, thereby reducing self-consciousness and so on. One person even commented that by sitting with his back to the camera, he believed he tended to be more comfortable than his lunch partner who often sat facing him, and therefore facing the camera and had commented about constant reminding of the recording.

When considering the effects of visibility and awareness, it is worth discussing the PAL project, even though no archival was designed into the software. Unlike the cameras and microphones used by CareLog and BufferWare, the microphone on PAL is built directly into the phone for other purposes (notably, making phone calls). Furthermore, the particular model of phone used included an embedded speakerphone. Thus, the owner of the phone easily could be using PAL and recording with the external microphone without it being visible to anyone nearby. In response to potential concerns about the lack of visibility, we added notification lights, again using the standard features of the phone. One area of the phone's outside shell glowed red when recording, green when playing back, and blue when paused. Ironically, when clipped into most belt clips (as many people chose to wear it), this feature was still covered. Ultimately, all four users in our deployment study also reported intentionally neglecting to inform people about recording, not because they were worried about objections, but because they didn't want to spend the time engaging in the conversation. In a later study of the conversation partner's attitudes, people reported wanting to be informed but ultimately typically trusting the recorder to keep and use the data for memory support as long as necessary (Iachello *et al.*, 2005).

The tension between wanting to be aware of capture generally and the potential issues that arise when that awareness comes from constant visibility and reminding should be explored further. Even people who are comfortable with recording generally can become self-conscious or uncomfortable at the specific time of capture. Thus, we should further explore the ways in which we can combine awareness, visibility, and notification in ways that are clear but avoid being too blunt and intrusive.

7.4 Trust

Issues of trust and the closeness of the relationships of various stakeholders, including the system creators, maintainers, and researchers can be fundamental to the acceptance of new capture technologies. Selective archiving was designed with features such as automatic deletion of content, but true acceptance requires trust that the policy is being followed and features were implemented as described. Furthermore, trust must exist between those people using and affected by the system. That is to say, those who might be recorded must trust those who are actuating the recording.

In the CareLog deployment, there were multiple opportunities to establish a trusting relationship amongst all concerned parties. Often, the staff members in the classroom already had a strong working relationship. There were only severe conflicts amongst staff members in one room, and in that room, each of those individuals independently developed a trusting relationship with me, often confiding in me about the problems with other staff. I was typically on site four of five school days each week and made myself available by phone, email, and in person to answer any and all questions. Through use of the system and my descriptions, people also reported being confident that the video was in fact being deleted when no one pressed an archive button. In fact, if anything, they expressed concerns about accidentally not recording what they wanted saved.

In one classroom, I also requested additional permissions from the staff and parents to share the videos that had been saved during the study for research purposes. I provided multiple options that each person could initial to be shared or not (*e.g.,* still pictures taken with CareLog vs. full audio and video with CareLog vs. the same with the handheld cameras, etc.). All staff members returned the permissions. One of them noted as he handed it to me, "I trust you, and there wouldn't be a point to letting you take all this video and then not let you use it." The teacher in the room held the form for the longest time (a few days) considering which elements she would allow to be shared and which she would not. Ultimately, she returned it to me with permission to share any of the information. When returning it to me, she said that she had decided to "trust [me] not to make [her] look like an idiot."

In the BufferWare deployment, there were many fewer opportunities to develop a trusting relationship. Furthermore, the fact that it was unclear to some people whose project it actually was meant that they were forced to trust the technology more generally, as opposed to the individuals involved. Those people who both knew who the researchers were and already had an established relationship with them commented that these friendships and trusting relationships were essential to accepting the system. Furthermore, the protections and trust relationship with Georgia Tech also supported these notions. People commented that if the system were available elsewhere (*e.g.,* a coffee shop or grocery store), they would be much more concerned, because they do not hold the same level of trust with those entities. On the other hand, people who did not associate BufferWare with particular trusted individuals or a trusted institution hesitated greatly about use. In many cases, they expressed distrust of where saved clips were going and for what they might be used. In other cases, they even distrusted that the data was being deleted at all.

An important adoption criteria for any new system, but particularly those that involve capture, is trust of the developers, owners, and maintainers of the system. Simply building in controls such as security of access or automatic deletion is not enough to put people at ease. They must also trust that these controls were implemented as described and are being monitored for potential abuse. Thus, when considering the designs of future capture applications, we must consider not only the affordances of the technology towards such issues as privacy and control of data but also towards building trust relationships and working within the social fabric and cultural constructs of the present context.

7.5 Features of Rich Media

Audio and video both provide an enormous amount of information. Often audio is considered to be even more personal and identifiable than video, but in the CareLog and BufferWare deployments, both were provided synchronously. The reactions to provision of these high bandwidth media were varied across the two cases, and inform our understanding of these spaces.

In the CareLog case, risk of capturing children on video without guardian consent, in particular is of great concern. In American schools, FERPA guidelines govern school records, and policies often indicate that video recording must only be used with explicit permission. Even without the audio channel, video of students (and for that matter, photographs) are closely regulated. Thus, early on, as described in Chapter Three, I explored the potential use of sophisticated techniques for blurring or blocking uninvolved students or those for whom permission has not been recorded. When these suggestions were describe to focus group participants discussing use of video for the care of children with special needs, the answer was unanimously that they would not use them.

Participants repeatedly voiced that the assessments would be inaccurate if they did not include the entire situational context.

It is worth noting that assessments conducted in person without video currently tend to rely on the teacher or perhaps one external observer to document the setting. Given that humans can only attend to so much detail at a time and that the behaviors often occur unexpectedly, it is unlikely that these reports would include all of the relevant information either. Similarly, CareLog only captures four camera angles all from the ceiling looking down and one sound stream. Thus, it is unlikely that this account includes all of the relevant context either. Data that may be important, such as temperature or humidity, is lost with this media.

Despite the limitations of audio and video at recreating the entire situational context, use of these rich streams of data did result in observations by the teachers above and beyond what would have been possible in the traditional model. For example, teachers commented on the ability to go back and observe the other students in the room at the time that one student was acting inappropriately, and thus receiving most of the staff attention. They were also able to observe small activities occurring just prior to an intense behavioral incident. These activities may not have been noticed the first time or may have been forgotten in the impending chaos of the incident. The flexibility of the media meant that a new depth of analysis and understanding could be reached and sometimes more data than was needed for the task at hand was collected and used for further classroom management activities.

BufferWare also included audio and video, although only one camera angle was used. Whereas the additional information available in this rich media was seen positively in the CareLog case, many people viewed it as overkill and too much of an invasion in the BufferWare case. Often, for example, they simply wanted an easily skimmable audio record of the conversation. Lack of appropriate access interfaces for such skimming meant that people did learn to take advantage of the video channel by holding up signs or gesturing at a particularly important portion of the conversation.

Other people commented that they simply wanted a record of what was on the whiteboard, and the ubiquitous availability of camera phones and digital cameras made explicit capture of the final artifact simpler than use of BufferWare. Better designed access interfaces for particular types of interactions (*e.g. a replay of the content of the whiteboard as it was added)* would greatly improve the system as it stands. Important to note, however, is that few people actually expressed a need for the full capabilities of audio and video simultaneously in an interaction. Thus, the flexibility built in with full access to this level of media is likely unnecessary in an informal space such as that used in the BufferWare project.

7.6 Face

Concerns about capture technologies can center on the ways in which captured data can be removed from one context and represented in another. The ability for people to manage their own image to others is compromised when one "face" can be removed and reinserted elsewhere. As mentioned in Chapter Six, issues of "face" as defined by Goffman (Goffman, 1955) came up repeatedly in analysis of reactions to BufferWare.

Although much more accepted than BufferWare, the CareLog deployment experiment also touched on issues of face and face negotiation by interested stakeholders.

During the CareLog deployment, teachers kept control of both capture and access of data saved through the CareLog interface. On the other hand, the researchers controlled the capture of data recorded using the handheld camera. Furthermore, teachers and staff never viewed those videos. In certain ways, they could more easily remember to present themselves in certain ways when a researcher was physically present with the camera. This very presence served as a visibible reminder that recording was taking place. As occurs frequently in field research, however, the participants tended to get used to our presence and carried on with their work as they likely would without us there.

Occasionally after a particularly intense experience, staff members would comment to us about what was being recorded. For example, an argument ensued between a teacher and a staff member that ended with the staff member being reassigned to a different room. Each of the people involved later apologized to me for having had to witness the argument. Each individual also then mentioned something about the way in which he or she might be portrayed in my video and whether that could or would be used by the school. I assured them that only researchers would view these videos, and that they should not be concerned with anyone else from the school viewing them. I could not assure them honestly that they might not appear negatively on the video, and so I concentrated on assuring them of who might have access. Thus, the faces they wish to present to other school staff, including their principal, would be preserved even if this presentation across the research staff could not be guaranteed. Although they appeared relieved after this situation, another intense afternoon occurred with the same teacher and a student later in the study, and we held a similar conversation. Again, the teacher appeared reassured, but in this end of study questionnaire, this same teacher expressed concerns about self-presentation using the handheld video camera, noting that the same worries did not exist for the CareLog recording.

As described in Chapter Six, in the BufferWare study, a large number of the expressed concerns about recording had to do with presentation of self and the negotiation of face. People were concerned about personal habits like scratching or nail-biting in which they might partake while sitting alone in the space but which they would not want recorded and shared with other people. In this case, although it may be embarrassing to be caught doing one of these small habits, it is generally considered of minimal concern when the viewing is transient. When it is recorded and can be shared outside of the context, however, concerns compound.

Another face negotiation issue that came up repeatedly in the BufferWare deployment involved the notions that space in the TSRB are for work, again bringing to mind boundary negotiation between home and work. People commented that they would not want to be recorded having fun or "goofing off" in this workspace. They did participate in these activities at times, but they reported not wanting to be caught nor recorded participating in them. They also noted that personal phone calls, often taken in the hallway to keep personal and work realms separate, should not be recorded in this work space, albeit a less formal space than other areas of the TSRB. Finally, people commented that they might engage in peripheral activities often associated with work, such as gossiping, but that these activities should not be recorded and do not meet the formal definition of what should be occurring in the cultural ideal of this particular workspace.

Rich media can be a powerful tool to support presentation of self in a desirable way. On the other hand, it can also be a powerful mechanism by which to share information that demonstrates a negative presentation of an individual. Many concerns about simple still photographs center on the way a person looks, with whom they might be and what that might imply, and so on. Audio and video taken out of context can be even more damaging. Thus, face negotiation and concepts of face are important notions for consideration when building capture applications. When the space is relatively informal, such as in BufferWare, and the capture can occur anytime, as in both cases, the potential risk for self-presentation can be quite large.

7.7 Decision Point

Selective archiving includes the inherent assumption that people are best equipped to make decisions about what they want recorded after an event has occurred. Deletion occurs automatically for data not marked to be saved, and manual deletion of saved data can occur at any time. However, people must choose to save data in close temporal proximity to the actual event. These choices about the decision point had impact on both the use and the acceptance of these technologies.

If you can predict a problem behavior's occurrence, it is very likely that you already know the function of that behavior and that you can implement a behavior intervention plan that will result in its reduction. Thus, FBA inherently requires the documentation of events that cannot be predicted. In this case, then, it is not surprising that the model of choosing to archive something after it occurs would be considered a positive way to make the decision.

I had some concerns, however, that the window for decision-making would be too small. That is to say, I worried that teachers might remember hours or even days later that they had not saved something they wished they had. In the end, the risk of false negatives was quite low, however, because they missed so many incidents with the pen and paper method. They rarely if ever considered if they had missed an incident in the CareLog condition. Furthermore, the risk of false positives was much higher. Recording extra information both caused more work for them to watch the videos and put them at risk of recording information that was damaging to a staff member or student without any benefit. In those cases, the manual deletion after they had already archived some piece of video addressed their needs.

In the BufferWare case, provision of after the fact decision-making was reported to be less important, and in fact, uncomfortable in some cases. People commented that notes were good enough for most informal meetings. Activities they would like recorded, such as practice presentations, could be set up ahead of time. Finally, those moments that they really needed to record unexpectedly, those "ah-hah" moments, were fewer and farther between than opportunities in which they expected to need to record. Reports from DUMBBO (Brotherton, *et al.*, 1999) and other informal meeting capture systems that required explicit startup indicate that the hurdle to start up is too high and that people generally don't expect to want to capture something enough to overcome that hurdle. BufferWare's design explicitly lowered the hurdle, but still people reported not needing that type of capture very frequently. Thus, it may simply be that even if made comfortable with recording, there is no optimal decision point for capture technologies for which situations of need are rare.

7.8 Summary

Technologies built to support one domain problem are often appropriated for other uses outside of the research setting. Thus, once the concepts of selective archiving were conceived, it became important to examine the ways in which the solution might generalize to other domain problems. In addition to exploring the concepts of selective archiving for behavioral assessment, using CareLog, I designed a flexible system that could be used for a variety of purposes and deployed it in a multi-purpose shared space.

This thesis focuses on three research questions regarding selective archiving:

- Do selectively archived segments provide a more efficient way to recover and to analyze higher quality data than available traditionally?
- What are the social and technical concerns and associated design considerations for using fully or semi-automated capture in the natural environment?
- How does selective archiving impact recording rich data in unstructured, natural settings?

As demonstrated in the CareLog case study, selectively archived segments of data can provide an efficient way to recover and to analyze high quality data that traditionally available. Teachers missed significantly fewer incidents and were able to understand the situations they were analyzing at a deeper level. They also were able to translate this data into immediate comprehension and thus into immediate changes to their practices. The level of quality of data equates directly to its usability and utility by the stakeholders, in this case the teachers. Not only were teachers more efficiently gathering this data, but they were more effectively using it, evidence of its superior quality.

The majority of the discussions in this final chapter center on the latter two research questions regarding the concerns associated with capture technologies and the impact of selective archiving on the settings in which these technologies are used. By examining the perceptions, adoption, and uses of these technologies together, I highlight features of design that must be considered when deploying capture technologies into everyday, unstructured settings. Who owns the data, not just who owns the capture technologies themselves, is an essential component to making an informed decision about capture technologies. Elements of choice about being in a recording or not also factor in, with people often avoiding those capture technologies they can and tolerating those they have less choice about avoiding.

Of course, without some level of visibility or awareness of these technologies, other considerations would not easily come into play. Like notions of awareness, trust often interacts with and is affected by other concepts. Considerations of such issues as who owns the data and whether or not that can be believed often center on trust. Furthermore, visibility of both capture and of system status and workings can increase both awareness and trust levels. The media to be captured itself often comes with particular affordances that must be considered both by designers and users. An appropriate richness of media should be supplied, no more and no less. Discovering what that level is both at the beginning of a situation and over time is a significant design challenge in creating capture technologies. Finally, use of recording and decision-making about that recording must fit into the social norms regarding showing and negotiating of face.

The CareLog and BufferWare projects provide much insight about the ways in which we can support record-keeping in informal and unstructured settings. Furthermore, when examined together, these projects provide a view into the larger generalized problem of unstructured capture and access and the acceptability of capture technologies. There is a wide spectrum of domain problems requiring capture and technologies to support those problems, however. These technologies should be explored both in direct consideration of particular domain problems and bearing in mind the themes uncovered in this work. Many of the features that enabled or prevented adoption of selective archiving in both the CareLog and BufferWare projects came from the design of the research, the organizational context, or other areas, with the technology itself holding only one piece of the puzzle. Thus, both selective archiving and other capture technologies should be considered as part of a larger set of socio-technical constructs. These constructs continue to evolve providing a dynamic system into which the placement of selective archiving technologies will likely provide more areas of future research as we continue to examine the uptake and appropriation of them over extended periods of time.

CHAPTER 8

CONCLUSIONS AND FUTURE WORK

Selective archiving provides support for people attempting to record information from everyday experiences. Because people can often recognize but not predict important moments, selective archiving grants users the possibility of deciding when to record something after it occurs. At the same time, the automatic disappearance of old data that was not noted to be important can protect people from unwanted or unnecessary recording. Despite these benefits for recording in everyday life, selective archiving, like other capture technologies, are still types of surveillance. In this dissertation, I described the model of selective archiving, the ways in which it has been and could be used, and the tension points that affect adoption, use, and perception of these and other recording technologies. This framework results from an initial exploration of the relationship between recording technologies and people's rights to privacy, sense of control, and feelings and concerns about surveillance. In this final chapter, I seek to examine the space of technical-human interactions that this framework sits within and begins to shed insight on

The American Heritage Dictionary defines surveillance as "**1.** Close observation of a person or group, especially one under suspicion. **2.** The act of observing or the condition of being observed" ("surveillance," n.d.) . This association of "suspicion" with "surveillance" has a long history. The etymology of the term surveillance indicates it emerged as a term in the English language in the early 1800's from the French terms indicating "over" (sur) and "to watch" (veiller). The term emerged in France as part of the Terror, a period of nearly a year during the French Revolution. This period is often described as a time when the state took on the character of totalitarian regimes, although many argue that in fact, struggles between rival factions led to mutual radicalization and large-scale violence (“surveillance,” n.d.). During this time, the term surveillance likely emerged as an a statement about the ways in which the various populations were being monitored to curb and in some cases to incite this violence. Importantly, then, surveillance has always included some negative connotation. Alternately, record as a verb has a neutral definition: 1. To set down for preservation in writing or other permanent form. 2. To register or indicate.

This brief discussion of only two of the potential ways in which the technologies included in this dissertation may be classified lays the groundwork for exploring the larger phenomena of the language to describe and perceptions of these technologies. The ways in which a record becomes an artifact of surveillance (and vice-versa) is interesting to consider. This distinction is ever changing. The moving target that is trying to understand the adoption and perceptions of recording technologies is subject to the overarching considerations of the culture and society within which they exist. These considerations also change as people form new mental models for understanding these technologies and as they encounter them more frequently. Thus, in this research, there remains a tension between understanding and articulation of these issues for the people impacted.

For the purposes of this dissertation, I define a "surveillance culture" as one in which people tend to be recorded a large majority of the time with or without their consent. This somewhat vague definition leaves open major questions about what it means to be a part of a surveillance culture and how people come to know they are part of said culture. These questions are not small and are presented as an indication of a large body of research yet to come. Furthermore, the United States in the early part of the twenty-first century is essentially a nascent surveillance culture, which is to say in parts of the country (notably urban centers and wealthy or heavily modernized suburban and rural areas), people are recorded a large majority of the time. At the same time, there are areas that are not yet blanketed with recording technologies. As large retail establishments, among other things, spread into these areas, however, the technologies go with them, including:

- tracking of sales information via credit card, frequent shopper cards, RFID, and other means
- video recording in the form of security cameras and other types of recording, and
- small, easily obtained personal recording devices, such as cameras, camera-phones, personal audio recorders, etc.

The field studies presented in this dissertation were conducted in the United States. Thus, much of the results can, were, and should be interpreted within the cultural and political norms of this society at this time. A thorough analysis of the ways in which the history of the socio-political infrastructure of the Unites States bore and continues to influence a particular set of American beliefs regarding recording technologies is reserved for future work. However, it is significant to consider two of the most often cited and relevant amendments in the Bill of Rights of the Constitution of the United States of America ("The Constitution of the United States," 1791) as framing the ways in which many Americans articulate their rights with respect to control, privacy, recording, and indeed surveillance.

Furthermore, highlighting these amendments here provides for the reader a chance to bring to the forefront many of the presumptions and underlying beliefs that they themselves may hold, particularly if American by birth or extended habitation.

Amendment I: Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech, or of the press; or the right of the people peaceably to assemble, and to petition the government for a redress of grievances.

Many of the concerns raised by researchers in the United Kingdom with regard to the CCTV movement (see for example, Dixon *et al.* 2003) center on the issue of freedom in the market square. That is to say, with the advent of recording technologies in these urban centers, the "out-group" that often includes the homeless, the youth, or other disenfranchised members of society no longer feels comfortable or able "peaceably to assemble." Rather, only the "in-group," those who are part of mainstream society can spend time at ease in these areas. At the same time, in the case studies presented in this paper, Americans regularly reported not being willing "to petition the government" or even to express their own "grievances" with regard to certain recording technologies and many discomforts. What then is occurring between these two nations, and indeed across the world, with regard to the changing nature of notions of freedom and of surveillance remains to be explored in much greater depth, even as it unfolds.

Amendment IV: The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue, but upon probable *cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.*

Many advocates of removal of recording technologies make arguments that echo those in the fourth amendment of the U.S. Constitution. Recording a person without his or her consent, particularly when the artifact created is used in a court of law to prosecute that individual, can be considered a violation of rights. A full review of the legal literature regarding this issue is well out of the scope of this dissertation, but it is important to understand that the basic rights provided here are often in debate in particular legal proceedings, and that these fundamental rights may form the basis for many reactions to recording, both positive and negative. In the research presented here, people often argued that they were comfortable and willing to adopt recording technologies, because they would be protected against "unreasonable" use of those records. On the other hand, others would describe use of these types of technologies as in violation of this type of protection. Thus, it is important to consider the ways in which the same fundamental shared cultural understanding of protection can be incorporated into very different models for comprehending and reacting to recording technologies.

Many people who are not comfortable with notions of surveillance when the record is a monolithic unified record (particularly one monitored by the government) choose instead a state of *piecemeal complacency*. In this model, they agree to each individual act of recording (*e.g.,* security cameras in public places, cookies on a laptop, health records at the doctor, etc.) in large part because they are not universally accessible as a combined view of that person by any single entity. Once these individual technologies are in place, however, the ability to piece the data together and create a unified record is hard to prevent.

8.1 Seven Tensions Revisited

The seven tension points introduced in chapter seven provide a framework against which we can assess and consider any individual recording technology and its potential domains of use and influence. They also present a way to examine the potential influences of these technologies as they become more pervasive and can be combined to create unified records. I present the potential of this framework briefly here noting that a more in depth analysis of these tension points both with emergent technologies and placed together is an extended piece of future work.

Ownership of Data: Who owns the data and how much of it they own may be two of the most important issues to consider when imagining a total surveillance culture. The comfort level with regard to recording changes greatly when people move from piecemeal records of themselves all owned by different entities to a universal record. Furthermore, as the infrastructure for computing, indeed ubiquitous or pervasive computing, expands, the ability for a person to perceive who owns data, where it is stored, and so on change dramatically. Finally, notions of shared publication and shared data ownership are becoming more commonplace with the advent of such collaborative software spaces as Google Documents (http://docs.google.com) and Flickr.com. These services create an environment in which people can easily share their data with a select group of individuals or with the entire world. At the same time, they implicitly then share the data with services that might mine this online data (e.g. the WayBackMachine at www.archive.org) as well as the corporate entities who host the sharing services initially.

Visibility and Awareness: Often, the emphasis with regard to data recording is on notification, and notification can often be achieved through visibility of a system. For example, by nature of seeing a camera and seeing a red recording light, a user knows that the camera is recording and can choose then to become further aware of what and why the recording is taking place through a variety of means. As recording devices shrink in size and cost and become more pervasive in their presence, however, people are simply less likely to be aware of them. They may ignore them because they are so saturated, or people may not see the devices due to their size and form factor. Even when notified about a recording technology, however, people may not understand that recording. That is to say, we must as designers critically consider breaking the natural link in our minds from notification to awareness to understanding and consent and recognize that people often have flawed mental models of recording technologies that inhibit proper and appropriate decision making for them. To this end, as we explore and design emergent recording technologies, we have a responsibility to enhance awareness through a variety of means while ensuring that visibility and notification strategies do not overwhelm users in an already cluttered world.

Trust: To accept fully any recording technology, people must both understand and trust the policies, people, and systems in place for that recording. Trust can be established by a firm understanding of the policies regarding retention and sharing of the data. In fact, the legal recommendations for data often surround these issues. In many cases, however, trust is a much more organic process, creating much difficulty for people wishing to pre-design for privacy preservation or wanting to create roles and rules for such systems. In my own work, people have most often decided to trust a technology because of a combination of trusting the people who have introduced it and their explanations of the pertinent policies and safeguards present in the systems. If that trust is violated, a new level of understanding must be reached before the equilibrium can be reset. As we examine the rapid proliferation of surveillance-related technologies, the cultural mores surrounding the policy makers, the governmental and commercial entities supplying the technologies, and other related groups change and adapt. Savvy consumers and stakeholders can convince others to trust or to fear such entities, and as designers of these technologies, it is our responsibility to ensure that these people can understand the potential benefits, the risks, and the technical underpinnings of these technologies so that they may decide who to trust in deploying them and when and in what situations their use is acceptable or even desirable.

Timing of Decision to Record: The primary difference in selective archiving over other models of recording is with regard to the timing of the decision to record, including both the timing of the decision to capture something and the timing of the decision to archive it. With selective archiving, a user makes the decision to save or to archive something in near proximity to the event, as in manual capture, only the decision is made afterwards. This choice is enabled by the fact that, like in fully automated capture, the decision has already been made always to record and always to discard after a period of time. This model works well for those times when the activity to be recorded is unpredictable and relatively infrequent. Other models are likely to work better for situations that do not fit this description.

Choice and Control: The policies inherent to selective archiving are both complex for people to imagine with little experience with the model and difficult to monitor. Control of the cache or buffer of data is in many ways implicit and invisible in use. Data is automatically deleted according to a policy that can be set by a user or by the system administrator depending on the particular application built on the selective archiving model. It is up to the applications then to handle the system transparency required to allow people to make proper decisions and have control of the data. As these systems become more pervasive, people's choices about whether to be a part of them are greatly diminished. Avoiding areas of surveillance is already a challenge for anyone in an urban city in the industrialized world, and at some point, daily life becomes too challenging if one is trying to avoid all recording entirely. Furthermore, many technologies are put forth ostensibly to support people who can not easily object, including those related to the care of children with autism who are uncommunicative. Other technologies, such as those to monitor formerly convicted criminals who are now paroled, are marketed as providing greater freedom to those who are monitored while protecting the safety of those who are free. Whether in fact these ideals prove true or not (and it is likely they will not), it is clear that neither the monitored nor the free have much power to decide the recording practices dictated by the policy makers.

Features of Rich Media: Unfortunately, much of the reasoning put forth both by designers of systems to support people and to monitor them, centers on the notion that these recordings are somehow the truth or reality. Ultimately, they can be only another account of a situation. That account may be extremely helpful, and indeed, I have found these recordings to be just that in my research and in my personal experiences. They can also be misleading, however, as described throughout this work. As these technologies become more prevalent, we as a society will be faced with regular choices regarding our own perceptions of the "truth" of a particular recording. Just as some people have over years and decades and centuries learned to be skeptical of the written text, and just as the joke that "it's on the Internet, so it must be true" came to be a popular expression, I imagine that video records and others will be subject to greater scrutiny as their prevalence grows. As designers, however, we must still think critically about how we can encourage users of these technologies to think critically themselves. We must expose the data provenance of our sensor streams and recording technologies. We must allow people to perceive and to understand when and where the choice was made to create that recording and how it was shared and ultimately displayed for their consideration. Only by recognizing the features of rich media, such as audio, video, and sensor streams, will we be able to benefit from and to reflect on the limitations of these data.

Face: Ultimately, much of what constitutes both cost and benefit of recording and archival technologies has to do with what is represented back out to the culture from which it originated or to other cultures existing at the same time or in the future. The rapid proliferation of recording technologies means that people are becoming more savvy with regard to the ways in which records can portray positive attributes of them. Through mass exposure to magazines, television, films, and pictures of ourselves, we can learn how to stand to take a flattering photograph. We can edit and adapt these records to show the ideal version of ourselves that we imagine. At the same time, people violate one another's ability to manage their own self-images by creating few safe spaces in the world, particularly the online world. Edited videos or those taken by hidden cameras are regularly used for anything from monitoring of workers (and potentially their hiring or firing) to cyber-bullying.

Selective archiving provides a model of recording that intends to put control in the hands of the people who are recorded. While this choice naturally means that those in control may then only show the most positive instances to those with power over them, it also provides a place of comfort from which people can use the technologies as works best for them. Indeed, in this research, the very fact that they controlled the image they presented meant that teachers were comfortable enough to share those incidents in which they knew they were not acting ideally. When they were not in control, they became much more concerned about the way recordings others were making might be used to damage their own self-image.

8.2 Summary:

The tenets of ubiquitous computing research not only enable but in many ways call for the widespread disbursement of cheap, small, easily used recording technologies. As we design and develop new technologies, enabling new interaction models, such as those presented in this dissertation with the selective archiving model of recordation, people must find a way to react to these technologies based on the various cues available to them. These cues can be physical, relying on what is in the environment or the device itself to give some clue about its functioning, purpose, and risks. They can also be social, in which people rely on others around them to understand how they might react to, use, or protest against such a technology. And finally, they are often experiential in that potential users of new ubicomp technologies must often try to understand a new system, device, or application based on experiences with similar technologies in the past. When no such similar technology exists, as is often the case in ubicomp research, people will nonetheless equate those things with which they are presented to those things they have previously experienced, as occurred in the work presented in this dissertation.

We, as designers, cannot necessarily design for all the ways a new technology is to be used, but we can uncover the underlying rules of the society and culture into which we may introduce them. We can then design these technologies to match those rules and/or to expose the underpinnings of the technologies in such a way as to allow people living within those cultures and societies to make proper judgments for themselves. We should design technologies to make them comprehensible to all stakeholders, including the policy makers, potential users, and others affected by their use. Furthermore, we have a responsibility to help these same people build appropriate mental models that empower them to make the "right" choices for them.

It is important to note that I abstain from value judgments with regard to the use of these technologies. I do not go so far as to claim that all technology is morally and ethically neutral, but many are. Ultimately, by providing the power to do "good" works, we may enable the "bad" as well, allowing for the sake of this argument that there even are truly "good" or "bad" activities in their entirety. Thus, any choices made by stakeholders may not be "right" for their friends, neighbors, society itself but they may be "right" for the decision makers themselves. As designers, we should work to ensure that each person impacted by the technology has enough understanding to make an informed decision. People may use our technologies for anti-social, aberrant or illegal activities. The goal, then, should be to ensure that when making those choices, people are doing so actively. Accidental disclosures and inadvertent harmful activities can be avoided with proper understanding. Thus, even when approaching the world with a model of responsibility that turns primarily on personal, cultural, and societal norms, rules, and obligations, we as technologists, designers, and researchers must still enable those mechanisms to work. They can only be successful if we design a balanced view of disclosure of technological workings, notifications and policies, and control and choice about use and subjectivity to recordings.

APPENDIX A: MATERIALS FOR FOCUS GROUP DISCUSSIONS OF CAPTURE TECHNOLOGIES

A.1 Focus Group Background Questionnaire (Caregivers, Professionals, Friends, and Families)

Name ______________________________________ (optional)

Age: 25 and under 26-35 36-50 51 – 65 65 and over

Highest education level completed:

High School College Post-Graduate degree

Primary job (stay at home parent, administrative assistant, consultant, attorney, etc):

____

I consider myself a caregiver of a child with special needs. Yes No
I consider myself one of the *primary* caregivers of a child with special needs. Yes No
I know but am not a caregivers for a child with special needs. Yes No

____

If you are a caregiver for a child with special needs:
List your caregiver role (e.g. parent, friend, teacher):

List multiple roles and note if you serve different roles for different children or different roles for the same child

____

Number of typical children for whom you care:
Number of children with autism spectrum disorder:
Number of children with other special needs:

Number of hours per week you spending in caregiving activities
(teaching, bathing, playing, keeping records about, making
and keeping doctor's appointments, feeding, etc.)
for children, both typical and with special needs:

Number of these hours that are specific to any special needs children:
(please elaborate)

Number of these hours specifically spent keeping records of care, progress, etc.:
(please elaborate)

Please **circle the item** on the scale which best approximates your level of agreement with the following statements.

Employees can control how information about them is collected and used in their organization.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
Most organizations handle information they collect about their employees in a proper and confidential way	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
Existing laws and organizational practices provide a reasonable level of protection for employee privacy today.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*

A.2 Focus Group Background Questionnaire – Participants with Asperger's Syndrome or High Functioning Autism

Name ______________________________________ (optional)

Age: 25 and under 26-35 36-50 51 – 65 65 and over

Your diagnosis on the autism spectrum:

Any special needs you have:

Highest education level completed:

What do you normally do during an average weekday?
(Job, School, other activities, etc.)

Please **circle the item** on the scale closest to how you feel:

Employees can control how information about them is collected and used in their organization.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
Most organizations handle information they collect about their employees in a proper and confidential way	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
Existing laws and organizational practices provide a reasonable level of protection for employee privacy today.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*

A.3 Experience Buffers Focus Group Discussion Guide Teachers and Caregivers

For amateur caregivers, substitute school and work with home or other location

(Total Session Time: 2 hours – 100 active minutes)

Introduction and Consent (10 minutes)

Purpose of the study will be reviewed and informed consent will be obtained from all group participants. We are interested in how technology can be used in inclusion classrooms to help teachers and para-professionals keep records of a child's progress and shares those records with other interested people.

Review guidelines – Facilitator will review the general guidelines for the sessions and set expectations:

- Everyone participates – want to hear everyone's opinions
- There are no wrong answers
- Think about how these topics could affect your own situation
- Session will be video-taped
- Confidentiality will be maintained: no names will be used in transcription or in any publications resulting from this research
- Session will last about 90 minutes

Introductions – Facilitator starts first, then go around the table –

- Name, brief personal introduction (e.g., job title, number of kids you care for)

Brief presentation of capture and access (10 minutes)

There are many developments occurring with technology that hold promise for improving the education and care for both typical children and children with special needs. One area we are interested in is the recording of experiences and providing access to that information and those experiences later. In particular, we are exploring tools that might help teachers and caregivers to share information and work together to solve certain problems.

Think about the behavioral and educational goals (or difficulties) of the children you care for.

What kinds of activities that you don't get to observe in person would you like to be aware of? What kinds of activities that you do get to observe do you wish you could share with others?

<Brief discussion here>
PROBE: Do you see this as related to your ability to teach/care?

<Allow for discussion here of whether this type of recording seems even a little useful>

Sharing information among caregivers (35 minutes)

Now, we would like to discuss the idea of sharing information that you might have recorded using techniques discussed in the last section. As we talk about sharing, please try to think both about how you would feel as the person who made the recording and was sharing it and how you would feel as the person who is reviewing someone else's recordings.

First, lets talk about the things that you keep records of already. What are some of the kinds of things that you track and how do you do this (pen and paper, keeping samples of work, pictures, video, etc)?

How much time do you have to dedicate to record keeping in a week?

What is the most frustrating part of keeping the records?

What is the most valuable?

With whom do you share this information? Why or why not?

PROBE: How would you feel about sharing other information like rich video data? (if they have not already discussed rich data that they might share)

LEAD INTO THE DIFFERENT MODELS OF RECORDING HERE

Recording with Three Models (automated, buffered, protected) (45 minutes)

Now, lets talk about ways that might be easier and more comfortable to you for recording information in your work. One way that some people think might be easier for you is if everything could be captured automatically. This way you would never have to remember to put in a new video tape or to set up the camera. Cameras would just be on and working in your class at all times, saving important videos, and marking them with other information (like the date, time, and who was in the room). This way, you could easily go back later and find anything you needed for your records.

PROBE:
Comfort level with saving, with sharing
Need to trim
Amount of time willing to spend trimming

Okay, another way that some people think might work is to have the same kind of automatic service, only the video doesn't get saved automatically. You have to choose to save video, otherwise it is deleted automatically after some amount of time that you could set (e.g. 15 minutes). If something important happened, however, you could save the video before it is deleted with the press of a button.

PROBE
Comfort level with saving, with sharing
Need to trim
Amount of time willing to spend trimming

A third way that some people think might be good is to have smart cameras. They would record all the time like in the first model we discussed, but only a subset of your classroom would be recorded, like a special table. Here we will show you a very brief video of this kind of recording.

PROBE
Comfort level with saving, with sharing
Need to trim
Amount of time willing to spend trimming

A fourth (and final) way to record is to have smart cameras like in the last case, but now instead of only showing a physical location, they only show a certain child (or children) and the space just around them. Here is a video of that kind of recording.

PROBE
Comfort level with saving, with sharing
Need to trim
Amount of time willing to spend trimming

Study experiences and wrap-up (10 minutes)
Now that we have given you some concrete examples, do you have anything to add from your earlier comments about the use of technologies to record and share information about children for whom you care?

Who do you think might benefit from this type of recording and sharing?
What advice would you want to give the researchers who are developing and studying these technologies?

Any final thoughts about using video in schools and in homes to record and share information?

A.4 Experience Buffers Focus Group Discussion Guide

Casual Participants

(Total Session Time: 1.5 hours – 70 active minutes)

Introduction and Consent (10 minutes)
Purpose of the study will be reviewed and informed consent will be obtained from all group participants.

Review guidelines – Facilitator will review the general guidelines for the sessions and set expectations:

- Everyone participates – want to hear everyone's opinions
- There are no wrong answers
- Think about how these topics could affect your own situation
- Session will be video-taped
- Confidentiality will be maintained: no names will be used in transcription or in any publications resulting from this research
- Session will last about 90 minutes

Introductions – Facilitator starts first, then go around the table –
- Name, brief personal introduction (e.g., job title, number of kids you care for)

Brief presentation of capture and access (10 minutes)
There are many developments occurring with technology that hold promise for improving people's abilities to remember and to share experiences. One area we are interested in is the recording of experiences and providing access to that information and those experiences later, especially those things that happen out in the world in unpredictable places. In particular, we are exploring tools that might help people to get important information from spontaneous events, that is things that they recognize as important but didn't plan for. Have you ever said "you had to be there" when things happen…. like that funny moment that your friend shot milk out his nose laughing, or that brilliant idea that you wished you had pen and paper to write down.

Think about some times when you wish you had a video/audio recorder or camera with you at the time. Think about some times when you had that equipment but still missed a moment you wished you had saved.

What kinds of experiences that you have do you wish you could share with others? What kinds of activities that you don't get to observe in person would you like to be aware of?

<Brief discussion here>

Recording with Three Models (automated, buffered, protected) (30 minutes)

Now, lets talk about ways that might make it easier to capture those moments. One way that some people think might be easier for you is if everything could be captured automatically. This way you would never have to remember to put in a new video tape or to set up the camera. Cameras would just be on and working in coffee shops, common areas, your home, etc., saving important videos, and marking them with other information (like the date, time, and who was in the room). This way, you could easily go back later and find anything you needed for your records as long as you could log onto say the Starbucks system that shows that coffee shop.

PROBE:
Comfort level with saving, with sharing
Way that they envision getting to this information
Comfort level with others getting to it.

Okay, another way that some people think might work is to have the same kind of automatic service, only the video doesn't get saved automatically. You have to choose to save video, otherwise it is deleted automatically after some amount of time that you could set (e.g. 15 minutes). If something important happened, however, you could save the video before it is deleted with the press of a button. In this model, you might save the information locally to your own device (say a cell phone) or save it to a central service like in the first model, but it would only be saved when you asked it to be.

PROBE
Willingness to save if goes to personal device versus goes to central server
Comfort level with others getting it if saved centrally

A third way that some people think might be good is to have smart cameras. They would record all the time like in the first model we discussed, but only a subset of the space would be recorded, like a special table. Here we will show you a very brief video of this kind of recording.

PROBE
Comfort level with saving, with sharing
Amount of time willing to spend searching and trimming once found what they want

A fourth (and final) way to record is to have smart cameras like in the last case, but now instead of only showing a physical location, they only show people who want to be shown and the space just around them. So, if you wanted to be recorded, you could wear something, and if not, you could take it off. Here is a video of that kind of recording.

PROBE
Comfort level with saving, with sharing
Amount of time willing to spend searching and trimming once found what they want

Study experiences and wrap-up (10 minutes)
Now that we have given you some concrete examples, do you have anything to add from your earlier comments about the use of technologies to record and share information about casual and spontaneous interactions?

Who do you think might benefit from this type of recording and sharing?
What advice would you want to give the researchers who are developing and studying these technologies?

Any final thoughts about using video in public places to record and share information?

APPENDIX B: PEN AND PAPER FBA FORMS

BEHAVIORAL OBSERVATION FORM

STUDENT: ______ DATE: 4/28 PAGE 1

Circle One: Mon Tues Wed Thurs **Fri** — **Full day** Absent Partial day: In____ Out____

TIME/ Duration	CONTEXT/ACTIVITY	ANTECEDENT/ SETTING EVENTS	IDENTIFIED TARGET BEHAVIORS	CONSEQUENCE/ OUTCOME	STUDENT REACTION	STAFF INITIALS
11:00	A, K	J, E,	3	A, C, B	E	EAR
11:05	M, L	A, F	1	BK, C	D	EAR
11:15	M	A, F	1	B, K, C	E	EAR
11:18	F	F	1	B, C,	E	EAR

	CONTEXT/ACTIVITY KEY	ANTECEDENT/SETTING EVENTS KEY	IDENTIFIED TARGET BEHAVIORS KEY	CONSEQUENCE/OUTCOME KEY	STUDENT REACTION KEY	
	A. Break	A. Request	1. Threw	A. Go to desk	A. Refused	
	B. Bathroom	B. Working	2. Hit	B. Time out room	B. Laughed	
	C. Calendar	C. Told no	3. Cleared surface	C. Pick up box	C. Continued	
	D. Academics	D. Increased noise	4. Pushed	D. Lose preferred item	D. Stopped	
	E. PE	E. Attention to others	5. Kicked	E. Removed from situation	E. Complied	
	F. Transition	F. Close proximity		F.	F.	
	G. Specials	G. Physical prompt		G. Physical Restraint	G.	
	H. Home Lab	H. Lost preferred item		H. Ignored	H.	
	I. Snack	I. Non preferred item		I. Verbal Reprimand	I.	
	J. Breakfast/lunch	J. Sitting		J. Clean up	J.	
	K. Emily out	K.		K. Continue Sd	K.	
	L. Ian out	L.		L.	L.	

CONTEXT/ACTIVITY: The student's environmental surroundings (*people, places, events*)
ANTECEDENT/SETTING EVENTS: Describe **exactly** what occurred in the environment just ***before*** targeted behavior was exhibited.
BEHAVIOR: Types of behavior displayed during incident
CONSEQUENCE/OUTCOME: What happened in the environment immediately ***after*** behavior was exhibited?
STUDENT REACTION: How did the student react ***immediately*** following the ***initial*** consequence being delivered?

M. Time out

FBA Data Analysis--Traditional Method

TIME OF DAY	Tally	Ratio	% INVOLVED
8:00-8:30			
8:31-9:00			
9:01-9:30			
9:31-10:00			
10:01-10:30			
10:31-11:00			
11:01-11:30	𝍸 |	6/17	
11:31-12:00			
12:01-12:30			
12:31-1:00			
1:01-1:30			
1:31-2:00	𝍸 |	6/17	
2:01-2:30	||||	4/17	
2:31-3:00	|	1/17	
3:01-3:30			

DAY OF WEEK	Tally	AVERAGE INCIDENTS PER DAY
MONDAY		
TUESDAY		
WEDNESDAY		
THURSDAY		
FRIDAY		

Directions: Tally the incidents in each of the columns. For the time of day the ratio is the total tallies divided by the total number of incidents over all days of data collection. For the day of the week the average incidents per day is the total tallies divided by the number of that day in the data sample.

CONTEXT	Letter	Tally	Ratio	% Involved
	A	卌	5/24	
	B			
	C			
	D			
	E	卌	5/24	
	F	|	1/24	
	G			
	H			
	I	||	2/24	
	J			
	K	卌 ||	7/24	
	L	||	2/24	
	M	||	2/24	

Directions: Go through the sheets and tally each context. The ratio is the total number of tallies over the number of total incidents. Percent involved is the result of the dividing the ratio.

ANTECEDENTS	Letter	Tally	Ratio	% INVOLVED
	A	𝍸 |	6/29	
	B	||	2/29	
	C	|	1/29	
	D	|	1/29	
	E	𝍸 |	6/29	
	F	𝍸 |	6/29	
	G	|	1/29	
	H	|	1/29	
	I	|	1/29	
	J	||||	4/29	
	K			

BEHAVIORS	Tally	Ratio	% INVOLVED

ANTECEDENTS	Letter	1 Throwing Objects	2 Hitting ~~Disruptive Outbursts~~	3 Clearing ~~Physical Aggression~~	4 Pushed	5 Kick
	A	I	[illegible]	II		II
	B					
	C					
	D					
	E	I	I	I	IIII	
	F	I				
	G					
	H					
	I	II		I	I	
	J					
	K	III	I	II	I	II
	L	II	I		I	
	M	II				

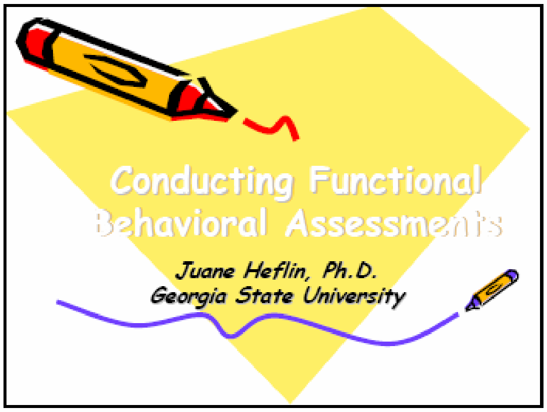
Directions: Look at the antecedent column and the targeted behavior column. Tally each antecedent in the column under the behavior that occurred. This will help you identify the typical behavior that occurs with each antecedent.

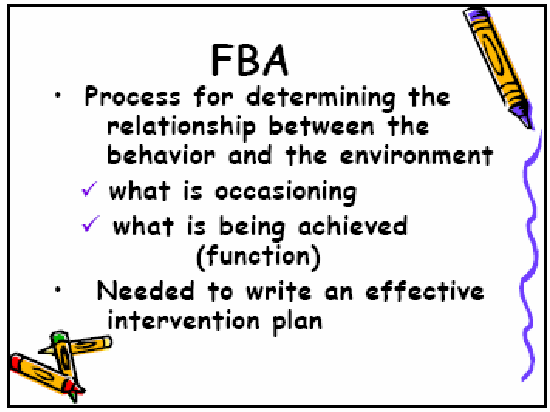
CONSEQUENCE	Letter	Tally	STUDENT REACTION		% Effective
			Stopped	Continued	
	A	III	II	I	67%
	B	卌 III	卌 III		100%
	C	卌	卌		100%
	D	II	I	I	50%
	E	II	II		100%
	F				
	G				
	H	III	II	I	67%
	I	II	I	I	50%
	J	III	II	I	67%
	K	IIII	III	I	75%

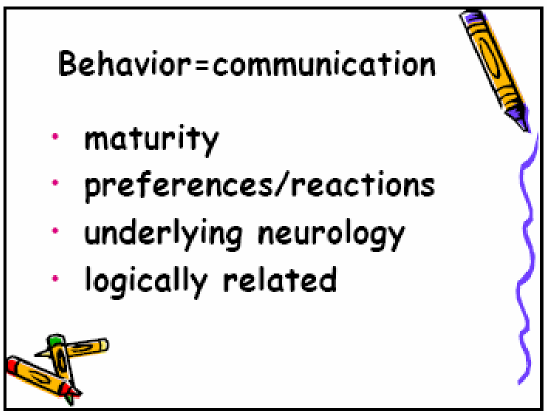
Directions: Tally each consequence and then look to see if the behavior stopped or continued and tally the result of the consequence. Divide the number of stopped tallies by the total number of tallies in the tally row. This is how effective the consequence was for that behavior. REMEMBER: "Effective" may mean the behavior achieved the desired function.

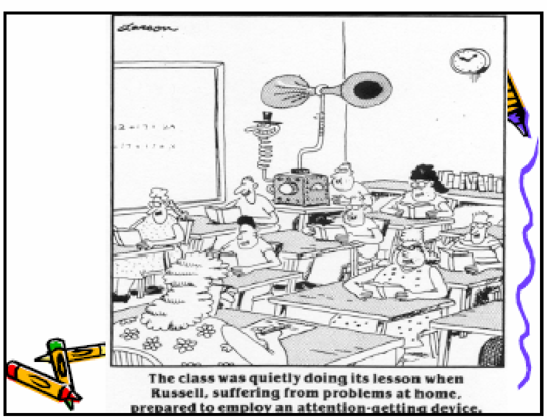
APPENDIX C: FBA TRAINING FOR TEACHERS

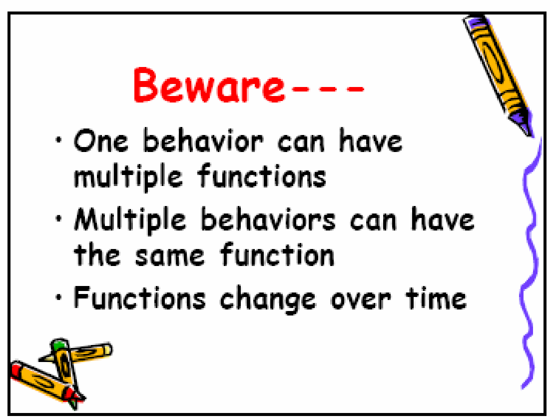
Conducted by Dr. Juane Heflin, College of Education, Georgia State University











Functional Perspective

Behavior occurs for a reason(s)

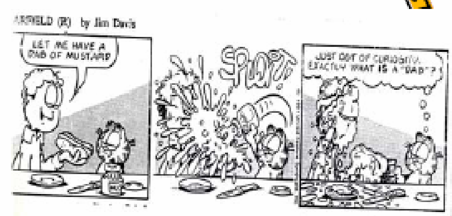
Ability to modify depends on ability to identify reason(s)

Functional Assessment

- Process
  - Target Behavior
  - Collect Data
  - Analyze Information

Narrow the focus:

- Identify problem behavior(s)
  - list
  - chains?
  - prioritize
  - operationalize



Step 1: Operational definition

- observable
- measurable
- clearly understood

Examples

Refuses to do work =

Tantrum =

Step 2: Collect Data

(6 questions)

- frequency
- where occur/not occur
- who for occur/not occur
- what during occur/not occur
- when most/least likely to occur
- student's reactions to consequences

Collect A-B-C Data

A = Antecedent

B = Behavior

C = Consequence

D = Student's reaction

Data Collection Formats

✓ Indirect

Advantages & Disadvantages

Indirect:

- FAST
- MAS
- PBQ

Data Collection Formats

✓ Indirect

✓ Direct

- Direct
  - scatter plot
  - standard ABC

Analyze data for:

- patterns
- predictability

If you can predict behavior, you can determine function.

Practice: Natasha

FAST
MAS

Practice: Natasha

Direct Data Collection

FBA

- Step 1?
- Step 2?

Step 3: Relationship Statement (hypothesis)

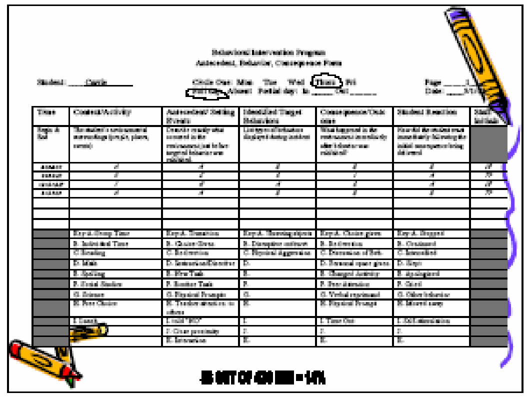
When ______________________,
(think slow and fast triggers)
the student will ________________,
in order to ____________________.

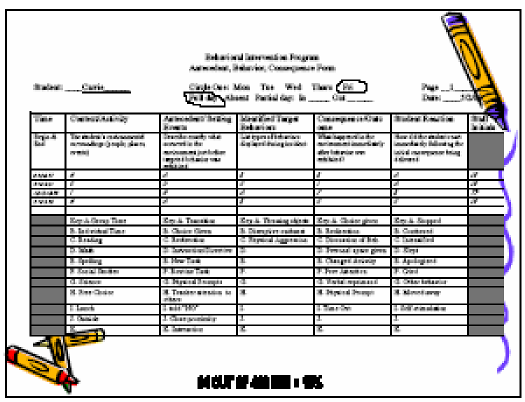
Practice:
examples
Natasha

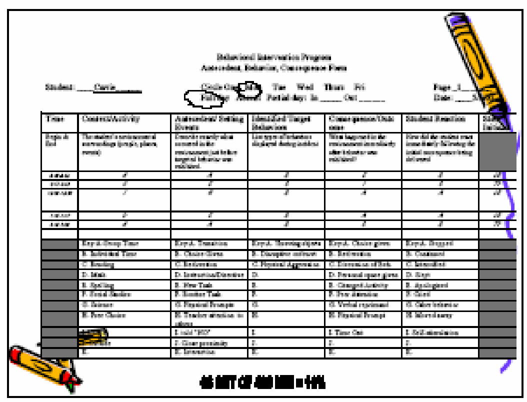
How do you come up with the relationship statement when dealing with complicated behavior?

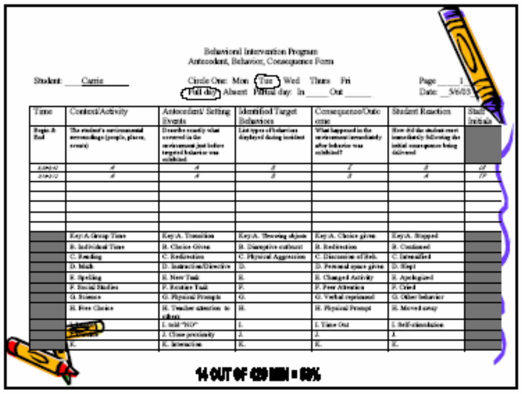
Carrie Case

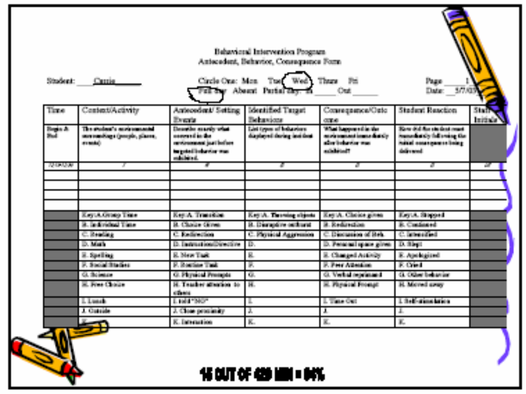
- Carrie is a sixth grade student with autism. She has two siblings who attend the nearby high school. Her mother works full time and her father frequently travels.
- Carrie is in your class of eight students.
- A paraprofessional is assigned to your class.








Behavioral Intervention Program
Antecedent, Behavior, Consequence Form
Student: Carrie
Circle One: Mon Tue Wed Thurs Fri
Full day Absent Partial day: In ____ Out ____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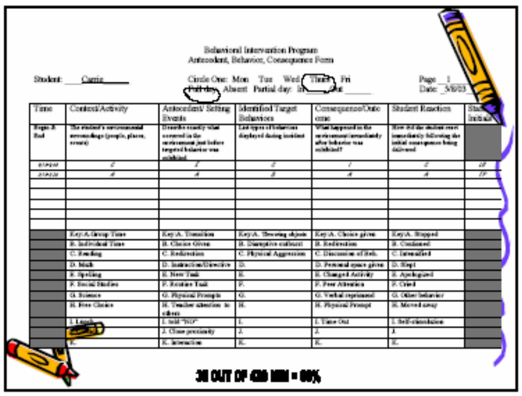
Student: Carrie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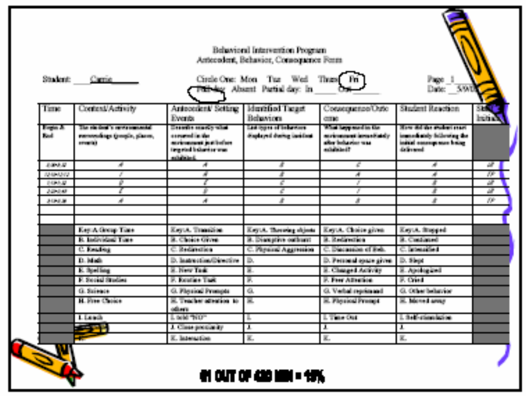
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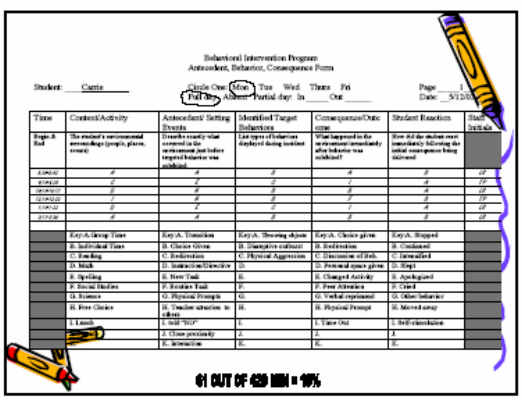
Student: Carrie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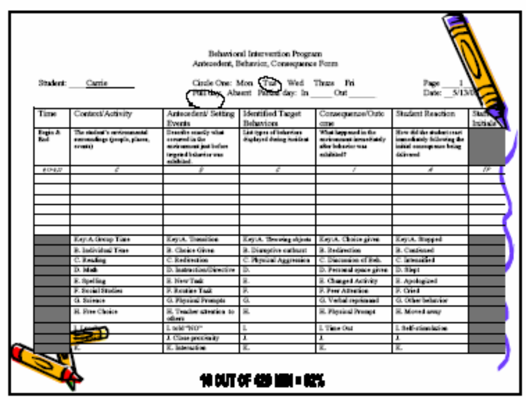

Behavioral Intervention Program
Antecedent, Behavior, Consequence Form
Student: Carrie

Behavioral Intervention Program
Antecedent, Behavior, Consequence Form

Student: Carrie   Circle One: Mon Tue Wed Thurs Fri   Page 1
Full day Absent Partial day: In ____ Out ____   Date: 5/14/

Time	Context/Activity	Antecedent/ Setting Events	Identified Target Behaviors	Consequence/Outcome	Student Reaction	Staff Initials
Begin & End	The student's environmental surroundings (people, places, events)	Describe exactly what occurred in the environment just before targeted behavior was exhibited.	List types of behaviors displayed during incident	What happened in the environment immediately after behavior was exhibited?	How did the student react immediately following the initial consequence being delivered	
[illegible]	D	E	C	I	B	[illegible]
[illegible]	A	A	B	A	A	[illegible]
	Key: A. Group Time	Key: A. Transition	Key: A. Throwing objects	Key: A. Choice given	Key: A. Stopped	
	B. Individual Time	B. Choice Given	B. Disruptive outburst	B. Redirection	B. Continued	
	C. Reading	C. Redirection	C. Physical Aggression	C. Discussion of Beh.	C. Intensified	
	D. Math	D. Instruction/Directive	D.	D. Personal space given	D. Slept	
	E. Spelling	E. New Task	E.	E. Changed Activity	E. Apologized	
	F. Social Studies	F. Routine Task	F.	F. Peer Attention	F. Cried	
	G. Science	G. Physical Prompts	G.	G. Verbal reprimand	G. Other behavior	
	H. Free Choice	H. Teacher attention to others	H.	H. Physical Prompt	H. Moved away	
	I. Lunch	I. told "NO"	I.	I. Time Out	I. Self-stimulation	
	[illegible]	J. Close proximity	J.	J.	J.	
	K.	K. Interaction	K.	K.	K.	

22 OUT OF 420 MIN = 05%

STUDENT: Carrie Case
DATE: July 13

DAYS OF DATA: 10

Average number of incidents daily: ____________________ Count Total divide by # of days of data

Average duration per incident: Divide total minutes by number of incidents ____________________

Total number of incidents: Just count ____________________

% of day engaged in behavior:

STUDENT: Carrie Case
DATE: July 13

DAYS OF DATA: 10

AVERAGE NUMBER OF INCIDENTS DAILY: 3.2

AVERAGE DURATION PER INCIDENT: 406/32= 12.69

TOTAL NUMBER OF INCIDENTS: 32

% OF DAY ENGAGED IN BEHAVIOR: 4200 total minutes (420 per day) 406/4200= 5.3%

TIME OF DAY	Tally	Ratio	% INVOLVED
8:00-8:30			
8:30-9:00			
9:00-9:30			
9:30-10:00			
10:00-10:30			
10:30-11:00			
11:00-11:30			
11:30-12:00			
12:00-12:30			
12:30-1:00			
1:00-1:30			
1:30-2:00			
2:00-2:30			
2:30-3:00			
3:00-3:30			

TIME OF DAY	Tally	Ratio	% INVOLVED
8:00-8:30		0/32	0%
8:30-9:00	111111	6/32	19%
9:00-9:30	111111	6/32	19%
9:30-10:00		0/32	0%
10:00-10:30	1	1/32	3%
10:30-11:00		0/32	0%
11:00-11:30		0/32	0%
11:30-12:00		0/32	0%
12:00-12:30	11111	5/32	16%
12:30-1:00	1	1/32	3%
1:00-1:30	1111	4/32	13%
1:30-2:00		0/32	0%
2:00-2:30	1	1/32	3%
2:30-3:00		0/32	0%
3:00-3:30	11111111	8/32	25%

DAY OF WEEK	Tally	AVERAGE INCIDENTS PER DAY
MONDAY ( )		
TUESDAY ( )		
WEDNESDAY ( )		
THURSDAY ( )		
FRIDAY ( )		

DAY OF WEEK	Tally	AVERAGE INCIDENTS PER DAY
MONDAY	111111 11111	5.5
TUESDAY	111	1.5
WEDNESDAY	111	1.5
THURSDAY	111111	3.0
FRIDAY	111111 111	4.5

CONTEXT	Letter	Tally	Ratio	% Involved
Group Time	a			
Individual Time	b			
Reading	c			
Math	d			
Spelling	e			
Social Studies	f			
Science	g			
Home Room	h			
Lunch	i			
Outside	j			

CONTEXT	Letter	Tally	Ratio	% Involved
Group Time	a	11111111111111 1	14/32	44%
Individual Time	b			
Reading	c	111111	6/32	19%
Math	d	11111	5/32	16%
Spelling	e	1	1/32	03%
Social Studies	f			
Science	g			
Home Room	h			
Lunch	i	111111	6/32	19%
Outside	j			

ANTECEDENTS	Letter	Tally	Ratio	% INVOLVED
Transition	A			
Choice Given	B			
Redirection	C			
Instruction/Directive	D			
New Task	E			
Routine Task	F			
Physical Prompts	G			
Teacher Attention to others	H			
Told "NO"	I			
Close Proximity	J			
Interaction	K			

BEHAVIORS	Tally	Ratio	% INVOLVED
Throwing Objects			
Disruptive Outbursts			
Physical Aggression			

ANTECEDENTS	Letter	Tally	Ratio	% INVOLVED
Transition	A	111111 111111 11	14/32	44%
Choice Given	B			
Redirection	C			
Instruction/Directive	D	111	3/32	9%
New Task	E	111111 11	8/32	25%
Routine Task	F			
Physical Prompts	G			
Teacher Attention to others	H	111111 1	7/32	22%
Told "NO"	I			
Close Proximity	J			
Interaction	K			

BEHAVIORS	Tally	Ratio	% INVOLVED
Throwing Objects	11	2/32	6%
Disruptive Outburst	1111111111111111 1111	20/32	63%
Physical Aggression	1111111111	10/32	31%

ANTECEDENTS	Letter	Throwing Objects	Disruptive Outburst	Physical Aggression
Transition	A			
Choice Given	B			
Redirection	C			
Instruction/Directive	D			
New Task	E			
Routine Task	F			
Physical Prompts	G			
Teacher Attention to others	H			
Told "NO"	I			
Close Proximity	J			
Interaction	K			

ANTECEDENTS	Letter	Throwing Objects	Disruptive Outbursts	Physical Aggression
Transition	A		IIIIIIIIIIIIII	
Choice Given	B			
Redirection	C			
Instruction/Directive	D			III
New Task	E		I	IIIIIII
Routine Task	F			
Physical Prompts	G			
Teacher Attention to others	H	II	IIIII	
Told "NO"	I			
Close Proximity	J			
Interaction	K			

CONSEQUENCE	Letter	Tally	STUDENT REACTION		% Effective
			Stopped	Continued	
Choice Given	A				
Redirection	B				
Discussion	C				
Personal Space Given	D				
Changed Activity	E				
Peer Attention	F				
Verbal Reprimand	G				
Physical Prompt	H				
Time Out	I				

CONSEQUENCE	Letter	Tally	STUDENT REACTION		% Effective
			Stopped	Continued	
Choice Given	A	111111	11111	1	83%
Redirection	B	11111111	111	11111	38%
Discussion	C	1111	11	11	50%
Personal Space Given	D				
Changed Activity	E	11		11	0%
Peer Attention	F	11		11	0%
Verbal Reprimand	G				
Physical Prompt	H				
Time Out	I	1111111111	11111	11111	50%

Analysis for Carrie

Behaviors are most likely to occur during: ____________________ or ____________________

Behaviors are most likely to stop when ________________ or ______________ occur

What do you think is the function of her behavior during group time?

What do you think is the function of her behavior during reading time?

What do you think is the function of her behavior during lunchtime?

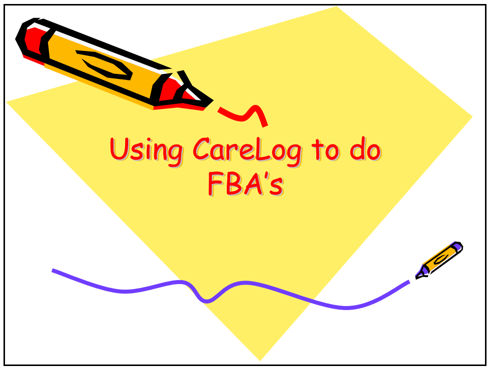
What day of the week are behaviors most likely to occur?

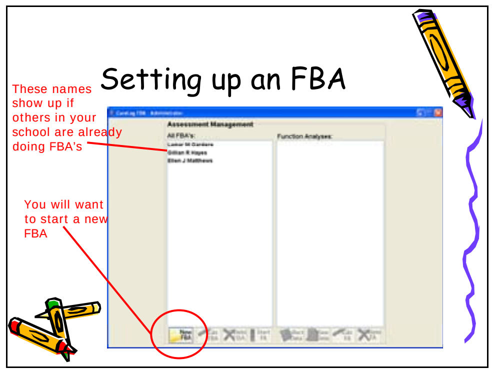
Why do you suppose Monday's and Friday's are most difficult for Carrie?

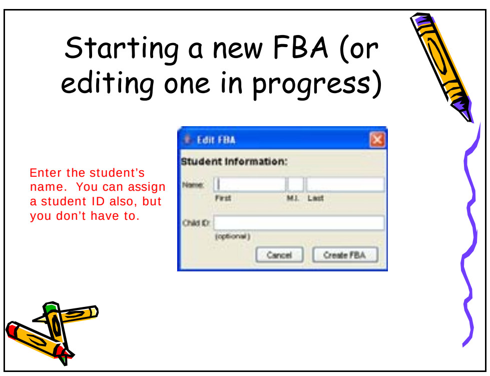
Summary

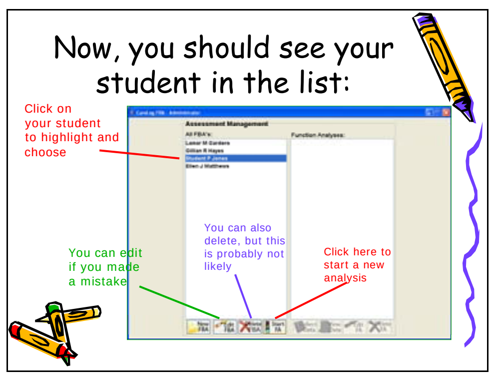
- Start with indirect to get idea
- Collect sufficient A-B-C data to have confidence the function(s) can be identified
- Develop relationship statement

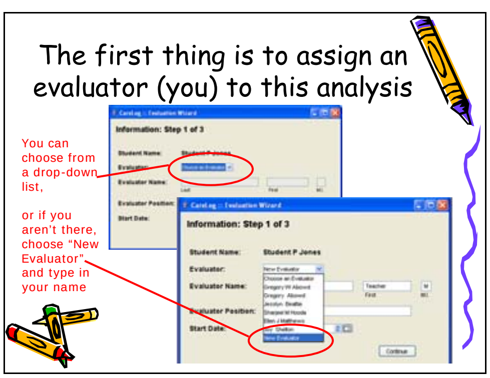
APPENDIX D: CARELOG TEACHER TRAINING

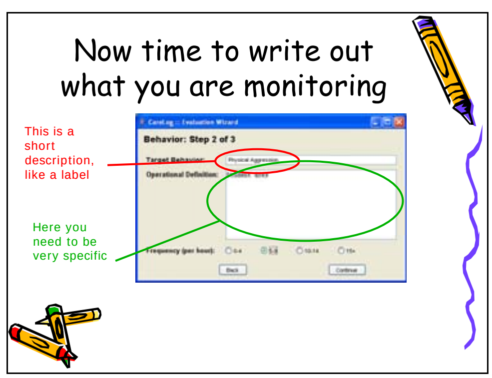


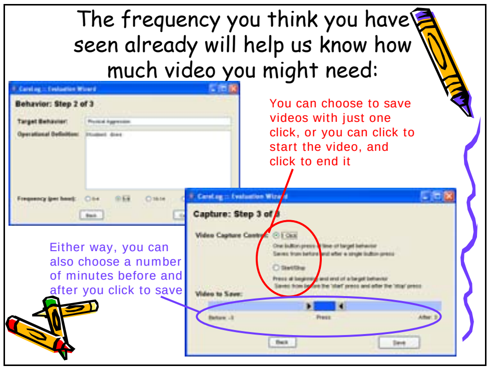




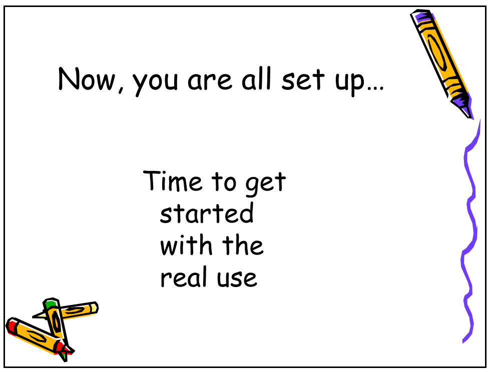


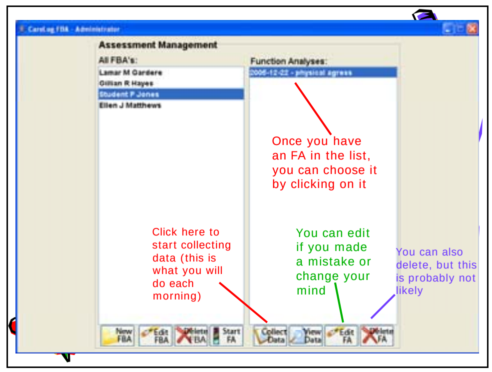


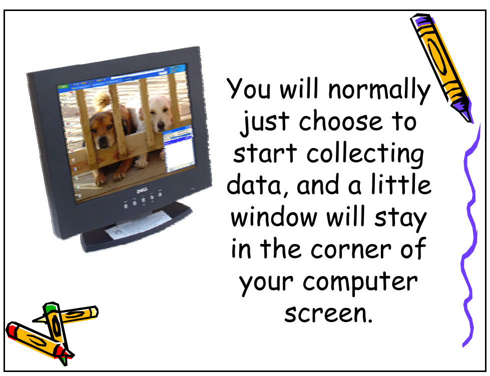


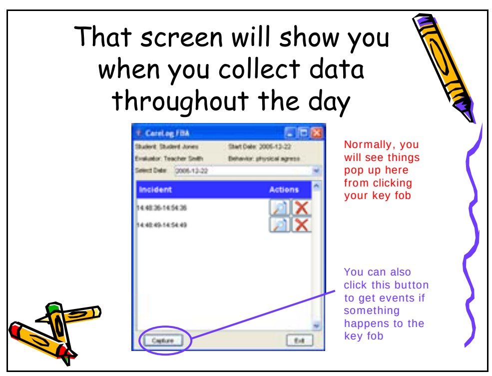

The frequency you think you have seen already will help us know how much video you might need:
You can choose to save videos with just one click, or you can click to start the video, and click to end it
Either way, you can also choose a number of minutes before and after you click to save

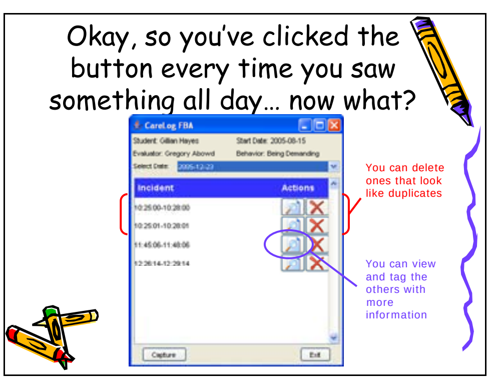

About that clicking…
On
Off
On
Off

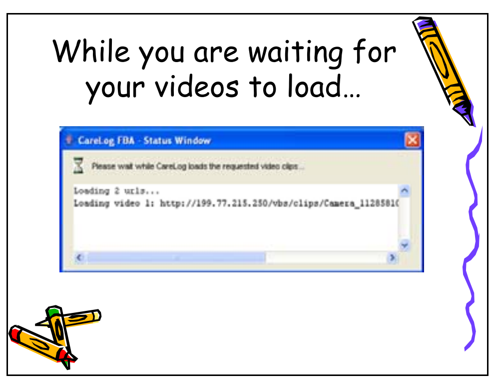

Now, you are all set up…
Time to get started with the real use

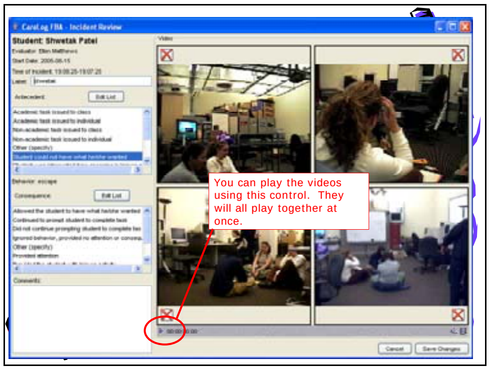

Assessment Management
Once you have an FA in the list, you can choose it by clicking on it
Click here to start collecting data (this is what you will do each morning)
You can edit if you made a mistake or change your mind
You can also delete, but this is probably not likely

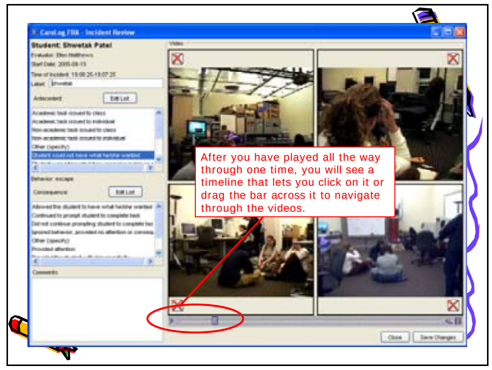

You will normally just choose to start collecting data, and a little window will stay in the corner of your computer screen.


That screen will show you when you collect data throughout the day
Normally, you will see things pop up here from clicking your key fob
You can also click this button to get events if something happens to the key fob

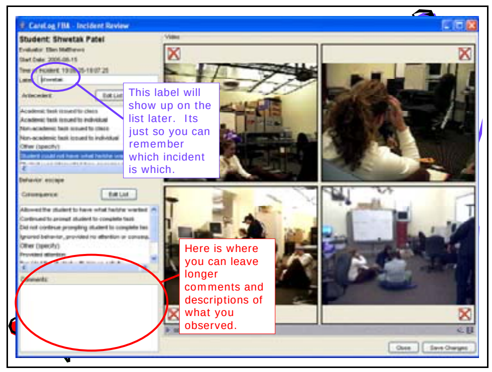

Okay, so you've clicked the button every time you saw something all day… now what?
You can delete ones that look like duplicates
You can view and tag the others with more information

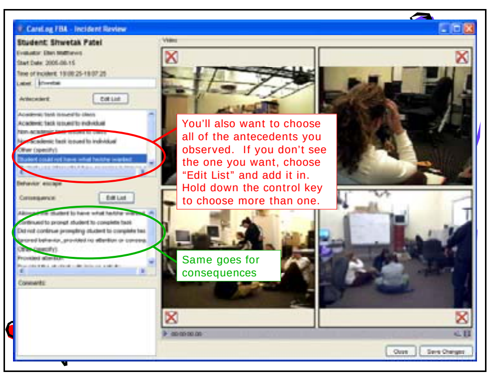

While you are waiting for your videos to load…
CareLog FBA - Status Window


You can play the videos using this control. They will all play together at once.

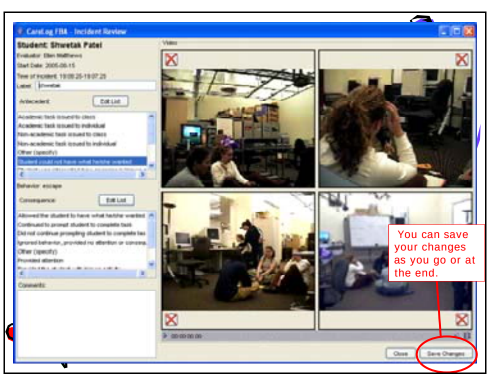

After you have played all the way through one time, you will see a timeline that lets you click on it or drag the bar across it to navigate through the videos.

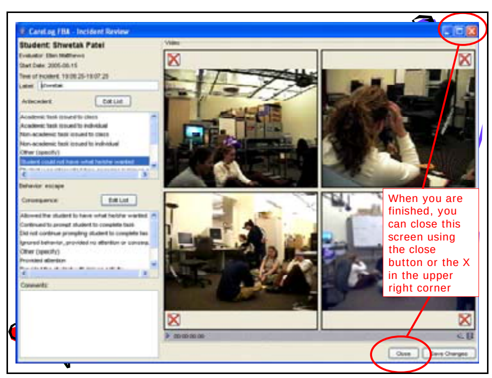

You can delete any video clip that you don't like or isn't helpful


This label will show up on the list later. Its just so you can remember which incident is which.
Here is where you can leave longer comments and descriptions of what you observed.


You'll also want to choose all of the antecedents you observed. If you don't see the one you want, choose "Edit List" and add it in. Hold down the control key to choose more than one.
Same goes for consequences

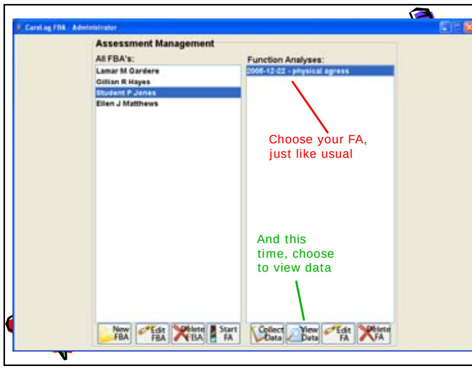

You can edit the list by selecting an antecedent to remove or by typing in one to add


You can save your changes as you go or at the end.

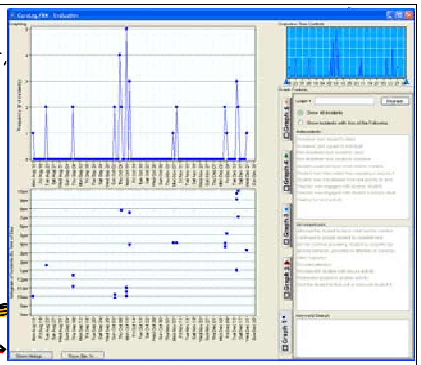

When you are finished, you can close this screen using the close button or the X in the upper right corner

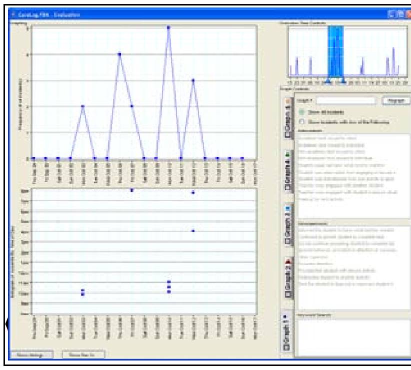
Time for Analysis

- You've reached data saturation, or at least you think you have
- Now, you want to see if there are any trends

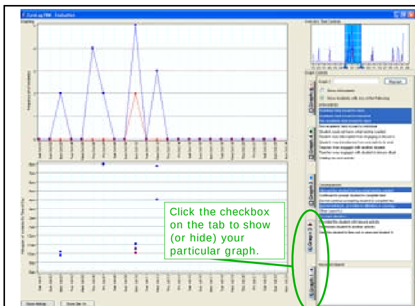


By default, you will see all of the saved data

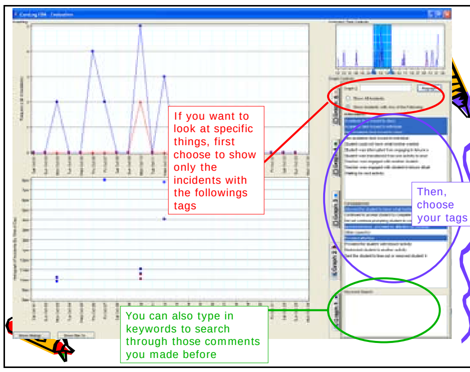


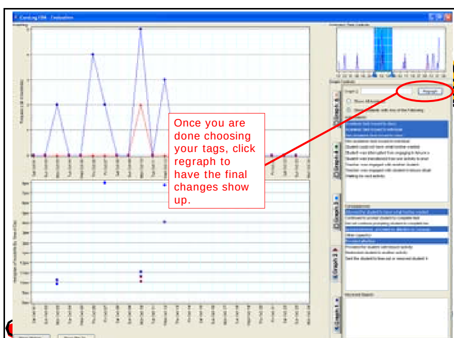


But you can zoom



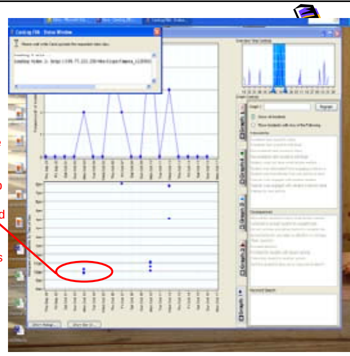
You can also show multiple graphs at once





By clicking on the graphs, you can get lists of all of the incidents that make up the point(s) you are interested in. This list will look just like the list you see each day. You can select multiple points or just one.

These points represent a single incident. So, clicking on one of them will bring up the video loading status window and eventually the incident review window that holds your videos and notes



Whew….

- I know that was a bit overwhelming.
- Don't worry! You can play with the software today, and we will be there the first day (or days if you want) that you are using it.

Now, can we ask just one more thing… help us sort out what this all means ☺

We want to know how hard this process is:

- How hard is it to **take basic incident** data (that something happened)?
  - Each day, please fill out a form for Basic Incident data (BI-1).
  - Each end of the week, please fill out a comparison form for basic incident data (BI-2)
- How hard is it to **take Antecedent, Behavior, Consequence** data?
  - Each day, please fill out a form for Basic Incident data (recording that something happened) (ABC-1).
  - Each end of the week, please fill out a comparison form for basic incident data (ABC-2)
- How hard is it to determine the function of the behavior?
  - When you are finished taking data, you will do your analysis. At this time, please fill out a DF-1 and a DF-2

We would like to find out a little more about how you feel about recording and sharing data

- Today, we have a background questionnaire that you already completed
- After each analysis is completed, we will ask you to fill out a questionnaire
  - so you'll do this twice
  - When you do the case with CareLog, there will be some extra questions

Finally, we want to know some things about the software:

- Anything you don't like about the software
- Anything you do like about it…

When you start with the software, we will bring you a small journal where you can tell us anything you think about CareLog… **anything**

Questions?

- If not today, don't worry…
  - You can email anytime:
    - gillian@cc.gatech.edu
    - lgardere@cc.gatech.edu
  - You can call Gillian **anytime**: 678-575-6622
  - We will be here when you first start using CareLog and throughout whenever you need us

APPENDIX E: SURVEY MATERIALS FOR CARELOG DEPLOYMENT

E.1 Teacher Background Questionnaire

Age: 25 or under 26-35 36 – 45 46 – 55 56 and over

Gender: Male Female

How long have you been teaching?

How long have you been teaching children with special needs?

How long have you been teaching children with autism?

Degrees obtained (*e.g.* B.S. in Education, Masters in Special Education):

Any special certifications? (If so, list)

Your familiarity with applied behavior analysis:
_____Little or no knowledge
_____Some knowledge but no practical experience
_____Some knowledge and practical experience
_____Extensive knowledge but no practical experience
_____Extensive knowledge with practical experience

Your familiarity with functional behavior assessment:
_____Little or no knowledge
_____Some knowledge but no practical experience
_____Some knowledge and practical experience
_____Extensive knowledge but no practical experience
_____Extensive knowledge with practical experience

Experience with computers
How often do you use a computer?
____Every day, multiple times per day
____Once a day
____A few times a week
____Once a week
____A few times a month
____Once a month
____Less than once a month

Do you have a computer at home? If so, please describe what you use it to do:

Do you regularly use a computer at school?

If so, please describe what you use it to do:

If so, where is it? (*e.g.* in teacher's lounge? In your classroom?)

Communication with parents and other caregivers:

How often do you typically communicate about the care of children with high behavioral needs with their parents?

____Every day, multiple times per day
____Once a day
____A few times a week
____Once a week
____A few times a month
____Once a month
____Less than once a month

Please describe any regularly scheduled meetings with parents:

How often do you typically communicate about the care of children with high behavioral needs with other teachers?

____Every day, multiple times per day
____Once a day
____A few times a week
____Once a week
____A few times a month
____Once a month
____Less than once a month

Please describe any regularly scheduled meetings with other teachers about particular children:

How often do you typically communicate about the care of children with high behavioral needs with professionals from outside the school (at the county, hired by parents, etc)?

____Every day, multiple times per day
____Once a day
____A few times a week
____Once a week
____A few times a month
____Once a month

____Less than once a month

Please describe any regularly scheduled meetings with other teachers about particular children:

Recording
For this section, please complete the statement with the appropriate value

I use video recording in my personal life (for dance recitals, birthday parties, etc).

Never	Less than once a year	Once a year	A few times a year	Once a month	A few times a month	Weekly	More than once a week

I take still pictures in my personal life

Never	Less than once a year	Once a year	A few times a year	Once a month	A few times a month	Weekly	More than once a week

I use video recording in the classroom to document educational progress (like learning a new skill)

Never	Less than once a year	Once a year	A few times a year	Once a month	A few times a month	Weekly	More than once a week

I use video recording in the classroom to document behaviors

Never	Less than once a year	Once a year	A few times a year	Once a month	A few times a month	Weekly	More than once a week

Privacy, Sharing and Control of Information
For this section, please note how much you agree or disagree with the statement

In general, employees can control how information about them is collected and used in their organization.

Strongly Disagree Disagree Agree Strongly Agree

Most organizations handle information they collect about their employees in a proper and confidential way

Strongly Disagree Disagree Agree Strongly Agree

Existing laws and organizational practices provide a reasonable level of protection for employee privacy today.

Strongly Disagree Disagree Agree Strongly Agree

School administrators, teachers, parents, and other caregivers do a good job of sharing information with each other.

Strongly Disagree Disagree Neutral Agree Strongly Agree

School administrators, teachers, parents, and other caregivers are considerate when it comes to how they use information about children.

Strongly Disagree Disagree Neutral Agree Strongly Agree

I am willing to share data I collect about a child with the child's parents if they ask to see it.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with the child's doctor if he/she asks to see it.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with other school employees if they ask to see it.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with the child's parents if I think it will improve the child's care.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with the child's doctor if I think it will improve the child's care.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with other school employees if I think it will improve the child's care.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

Information about schools and classrooms
For this section, please note how much you agree or disagree with the statement

In public schools, information collected about a child's behavior can be misused.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

In public schools, information collected about a child's behavior is misused.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

Teachers are involved with decisions about managing the data collected about children in their classrooms.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

The Individuals with Disabilities in Education Act (IDEA) affects how I do my job.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

No Child Left Behind affects how I do my job.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

Family Educational Rights and Privacy Act (FERPA) affects how I do my job.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I feel involved in the management of behavior and students in my classroom.

Strongly Disagree Disagree Neutral Agree Strongly Agree

I am able to handle behavior problems in my classroom.

Strongly Disagree Disagree Neutral Agree Strongly Agree

E.2 Questionnaire During CareLog Study

Completed after each FBA is conducted

Communication with parents and other caregivers:

How often did you communicate with the parents of the child who was the subject of the FBA?

____Every day, multiple times per day
____Once a day
____A few times a week
____Once a week
____Less than once a week

Please describe any regularly scheduled meetings with the parents:

How often did you communicate with other people in the school about the child who was the subject of the FBA?

____Every day, multiple times per day
____Once a day
____A few times a week
____Once a week
____Less than once a week

Please describe any regularly scheduled meetings with other people inside the school:

How often did you communicate with other people outside the school about the child who was the subject of the FBA?

____Every day, multiple times per day
____Once a day
____A few times a week
____Once a week
____Less than once a week

Please describe any regularly scheduled meetings with other people outside the school:

Privacy, Sharing and Control of Information
For this section, please note how much you agree or disagree with the statement

I am willing to share data I collect about a child with the child's parents if they ask to see it.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with the child's doctor if he/she asks to see it.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with other school employees if they ask to see it.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with the child's parents if I think it will improve the child's care.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with the child's doctor if I think it will improve the child's care.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am willing to share data I collect about a child with other school employees if I think it will improve the child's care.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

Conducting an FBA was straightforward.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Conducting an FBA was complicated.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Conducting an FBA was demanding.

Strongly Disagree Disagree Neutral Agree Strongly Agree

It is valuable to my work if I can conduct an FBA.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Conducting an FBA increases my confidence that I can change this child's behavior.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Conducting an FBA increases my effectiveness as a teacher with this child.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Conducting an FBA increases my effectiveness as a teacher with other children.

Strongly Disagree Disagree Neutral Agree Strongly Agree

I feel involved in the management of data collected in my classroom.

Strongly Disagree Disagree Neutral Agree Strongly Agree

I feel involved in the management of behavior and students in my classroom.

Strongly Disagree Disagree Neutral Agree Strongly Agree

I am able to handle behavior problems in my classroom.

Strongly Disagree Disagree Neutral Agree Strongly Agree

I understand why the children in my classroom show inappropriate behaviors and characteristics.

Strongly Disagree Disagree Neutral Agree Strongly Agree

I was able to record everything that I wanted to say about an incident at the time of the incident.

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

I was able to record everything that I wanted to say about an incident eventually.

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

CareLog Questions
(NOTE: THIS SECTION WAS ONLY INCLUDED AFTER THE CONDITION THAT INVOLVED USE OF VIDEO AND CARELOG)

For this section, please circle the statement that best describes you.

I would use video recording in the classroom to document educational progress (like learning a new skill)

Never	Less than once a year	Once a year	A few times a year	Once a month	A few times a month	Weekly	More than once a week

I would use video recording in the classroom to document behaviors

Never	Less than once a year	Once a year	A few times a year	Once a month	A few times a month	Weekly	More than once a week

I would use CareLog in the classroom to document educational progress (like learning a new skill)

Never	Less than once a year	Once a year	A few times a year	Once a month	A few times a month	Weekly	More than once a week

I would use CareLog in the classroom to document behaviors

Never	Less than once a year	Once a year	A few times a year	Once a month	A few times a month	Weekly	More than once a week

*For this section, please note how much you agree or disagree with the statement

Video recording, even without CareLog, would help me to document behaviors in my classroom.

Strongly Disagree   Disagree   Neutral   Agree   Strongly Agree

Any extra comments?

CareLog would help me to document behaviors in my classroom.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

CareLog was easy to use.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

CareLog was time consuming to use.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I enjoyed using CareLog.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I understand how CareLog works.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I feel comfortable using CareLog and its videos in my classroom.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I would use CareLog even if it didn't automatically throw away video I didn't want to save.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?
The video recording in CareLog makes me uncomfortable.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I am concerned about who has access to the video snippets I recorded with CareLog.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

I would like to know who looks at the video snippets I recorded with CareLog.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

The graphs in CareLog helped me to diagnose the function.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

Access to the videos in CareLog helped me to diagnose the function.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

Access to the details of a particular incident in CareLog helped me to diagnose the function.

Strongly Disagree Disagree Neutral Agree Strongly Agree

Any extra comments?

APPENDIX F: NASA TASK LOAD QUESTIONNAIRE DETAILS

During both of the treatments (use of traditional pen and paper tools and use of CareLog software), I attempted to assess the load of three different portions of the experience:

(1) Capturing the initial data, that is recording that something happened. In the traditional method, this can sometimes mean homegrown collection strategies (including moving pennies from one pocket to another, using strips of masking tape on the arm to count incidents, etc.). Using CareLog, this means pressing a button at the time something happens.

(2) Capturing the Antecedent and Consequence (ABC) information, often including some subjective observations made by the teacher. In the traditional method, this usually entails handwriting some information on to the forms for data collection. With CareLog, this includes typing into the software interface or selecting from a list of potential antecedents and consequences already stored.

(3) Doing the data analysis and determining the function of the behavior. In both methods, the teachers will examine the data collected and use it to determine what they think may be causing or reinforcing the behavior.

To assess task load at each of these stages, I used the following questionnaires as follows:

(1) Teachers completed BI-1 at the end of each day asking teachers to reflect on how difficult it was to record the basic information that an incident occurred. They completed ABC-1 at the end of each day asking teachers to reflect on how difficult it was to record the antecedent and consequence data.

(2) Teachers completed BI-2 and ABC-2 to get comparative load ratings at the end of the first day of each week, because these ratings change much less frequently for most people, and we want to reduce the burden of the subjects.

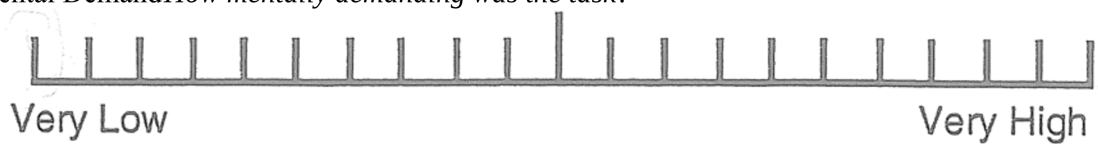
(3) Finally, teachers completed DF-1 and DF-2 at the end of the study, once the they had completed the process of determining the function of the behavior.

F.1 Sample task load forms used by teachers

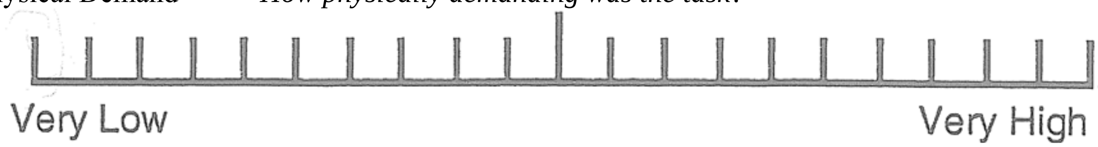
(BI-1)Rating for experience with taking basic incident data

For each of the following, please **circle one of the vertical lines** that indicates how you feel about your experience *today* with recording the occurrence of an incident.

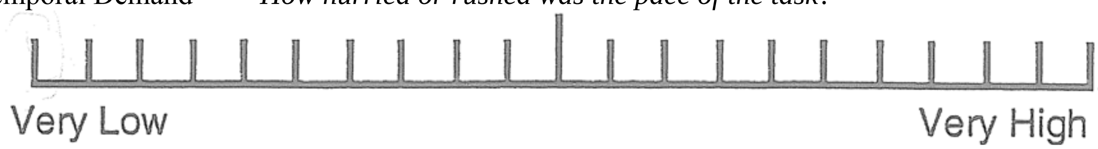
Mental Demand*How mentally demanding was the task?*



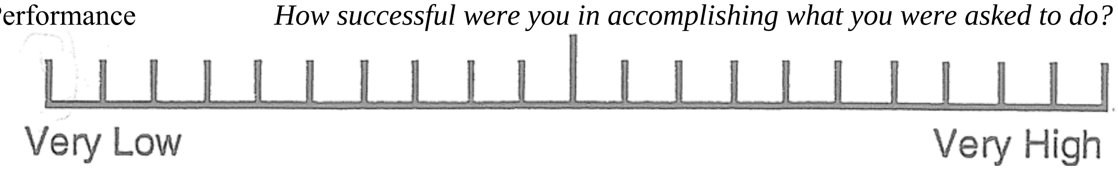
Physical Demand *How physically demanding was the task?*



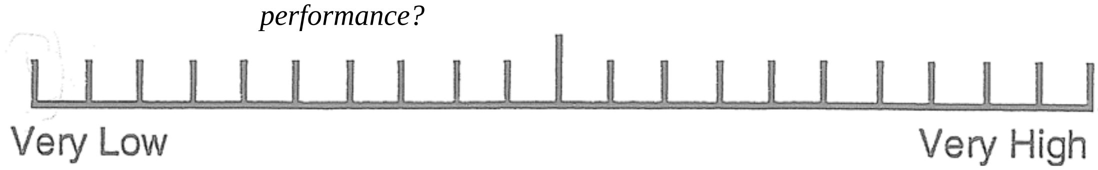
Temporal Demand *How hurried or rushed was the pace of the task?*



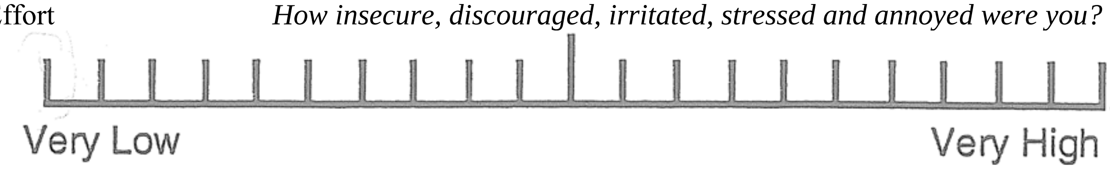
Performance *How successful were you in accomplishing what you were asked to do?*



Effort *How hard did you have to work to accomplish your level of performance?*



Effort *How insecure, discouraged, irritated, stressed and annoyed were you?*



(BI-2) Comparison rating with taking basic incident data

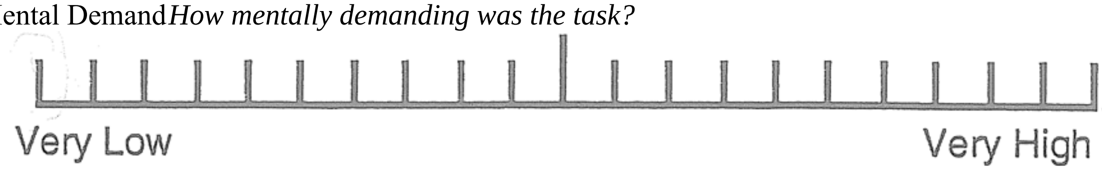
For each of the following, please place a mark to indicate which of the two was more demanding for you.

1.	______Physical Demand	OR	______Mental Demand
2.	______Temporal Demand	OR	______Mental Demand
3.	______Performance	OR	______Mental Demand
4.	______ Frustration level	OR	______Mental Demand
5.	______ Effort	OR	______Mental Demand
6.	______ Temporal Demand	OR	______Physical Demand
7.	______ Performance	OR	______Physical Demand
8.	______ Frustration Level	OR	______Physical Demand
9.	______ Effort	OR	______Physical Demand
10.	_____ Temporal Demand	OR	______Performance
11.	_____ Temporal Demand	OR	______Frustration Level
12.	_____ Temporal Demand	OR	______Effort
13.	_____ Performance	OR	______Frustration Level
14.	_____ Performance	OR	______Effort
15.	_____ Effort	OR	______Frustration Level

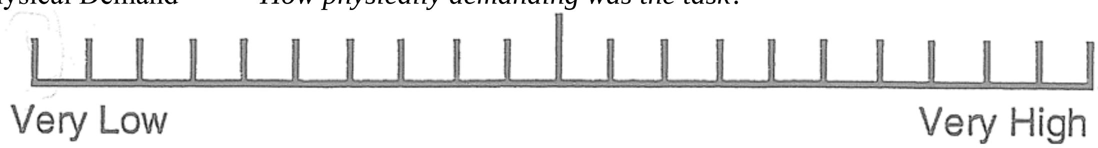
(ABC-1)Rating for experience with taking ABC incident data

For each of the following, please **circle one of the vertical lines** that indicates how you feel about your experience *today* with recording the occurrence of an incident.

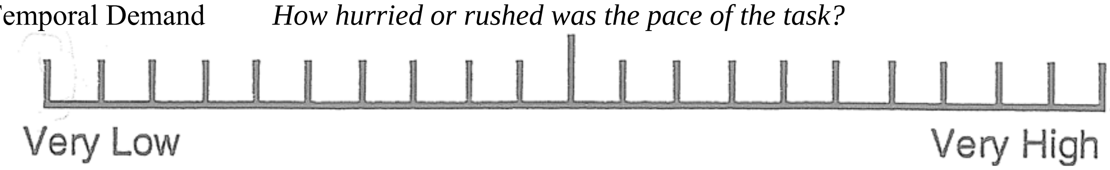
Mental Demand *How mentally demanding was the task?*



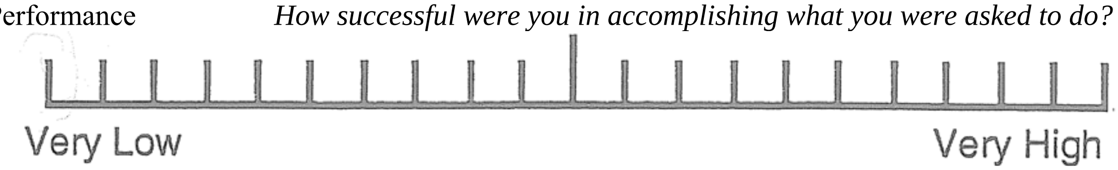
Physical Demand *How physically demanding was the task?*



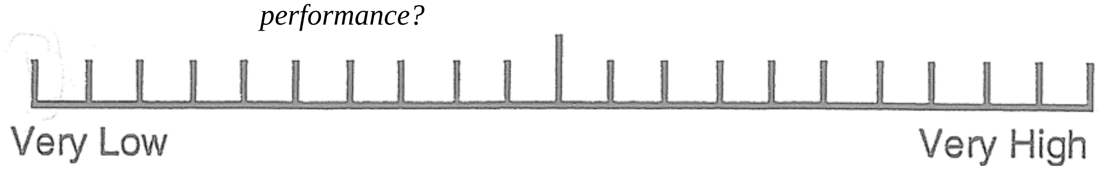
Temporal Demand *How hurried or rushed was the pace of the task?*



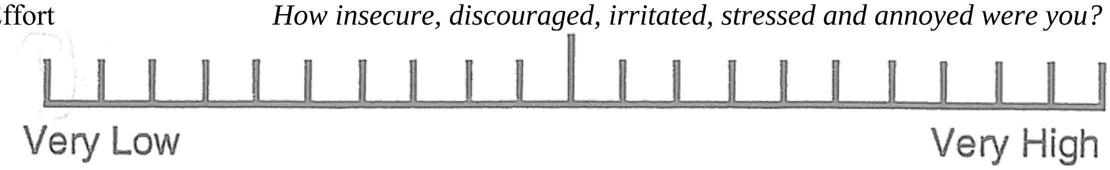
Performance *How successful were you in accomplishing what you were asked to do?*



Effort *How hard did you have to work to accomplish your level of performance?*



Effort *How insecure, discouraged, irritated, stressed and annoyed were you?*



(ABC-2)Comparison rating with taking ABC incident data

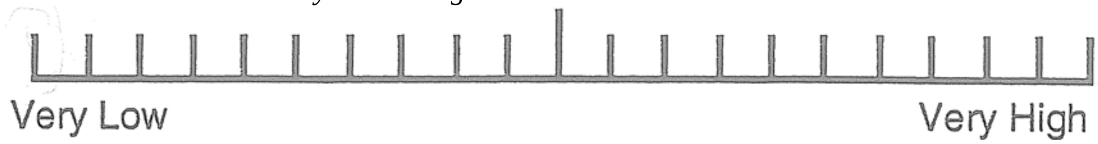
For each of the following, please place a mark to indicate which of the two was more demanding for you.

1.	______Physical Demand	OR	______Mental Demand
2.	______Temporal Demand	OR	______Mental Demand
3.	______Performance	OR	______Mental Demand
4.	______ Frustration level	OR	______Mental Demand
5.	______ Effort	OR	______Mental Demand
6.	______ Temporal Demand	OR	______Physical Demand
7.	______ Performance	OR	______Physical Demand
8.	______ Frustration Level	OR	______Physical Demand
9.	______ Effort	OR	______Physical Demand
10.	_____ Temporal Demand	OR	______Performance
11.	_____ Temporal Demand	OR	______Frustration Level
12.	_____ Temporal Demand	OR	______Effort
13.	_____ Performance	OR	______Frustration Level
14.	_____ Performance	OR	______Effort
15.	_____ Effort	OR	______Frustration Level

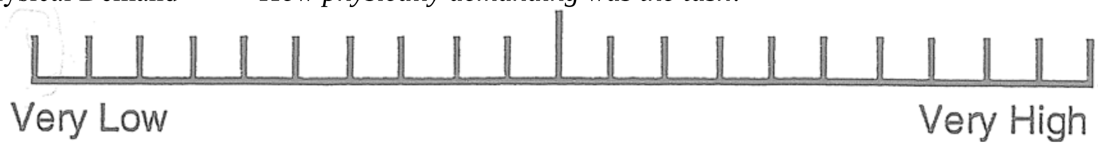
(DF-1)Rating for experience with determining function

For each of the following, please **circle one of the vertical lines** that indicates how you feel about your experience *today* with recording the occurrence of an incident.

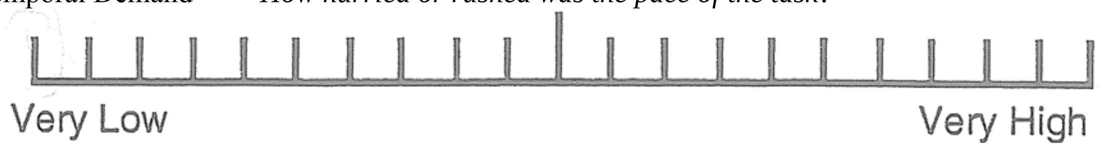
Mental Demand *How mentally demanding was the task?*



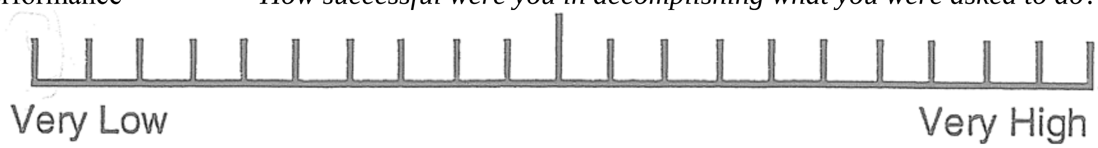
Physical Demand *How physically demanding was the task?*



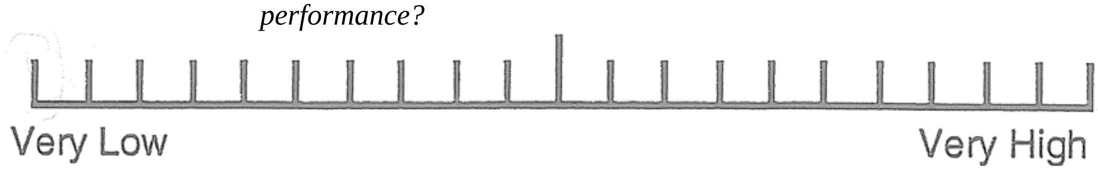
Temporal Demand *How hurried or rushed was the pace of the task?*



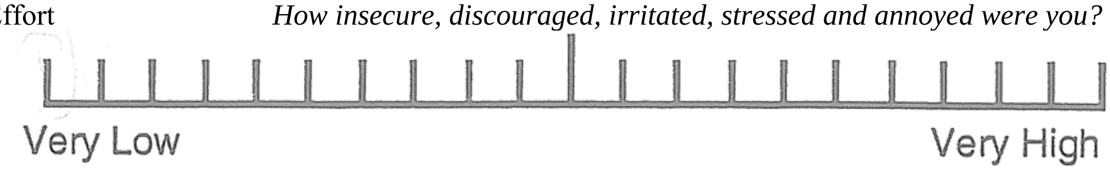
Performance *How successful were you in accomplishing what you were asked to do?*



Effort *How hard did you have to work to accomplish your level of performance?*



Effort *How insecure, discouraged, irritated, stressed and annoyed were you?*



(DF-2)Comparison rating with determining function

For each of the following, please place a mark to indicate which of the two was more demanding for you.

1. ______Physical Demand	OR	______Mental Demand
2. ______Temporal Demand	OR	______Mental Demand
3. ______Performance	OR	______Mental Demand
4. ______ Frustration level	OR	______Mental Demand
5. ______ Effort	OR	______Mental Demand
6. ______ Temporal Demand	OR	______Physical Demand
7. ______ Performance	OR	______Physical Demand
8. ______ Frustration Level	OR	______Physical Demand
9. ______ Effort	OR	______Physical Demand
10. _____ Temporal Demand	OR	______Performance
11. _____ Temporal Demand	OR	______Frustration Level
12. _____ Temporal Demand	OR	______Effort
13. _____ Performance	OR	______Frustration Level
14. _____ Performance	OR	______Effort
15. _____ Effort	OR	______Frustration Level

F.2 Analysis of Task Load Data

Overview of Tool

The NASA Task Load Index (NASA-TLX) was developed to measure the overall complexity of a task in outer space. This allows different tasks to be compared for their overall complexity for a human to complete. I am using it to understand the workload differences between the pen and paper case and the new experimental case of using CareLog to conduct FBA's. Importantly, these are NOT the exact same tasks when I show comparisons. This difference is because in each condition, the teachers are conducting assessments of different children. Furthermore, I have adapted the scales in the way in which the data was collected. Each teacher was asked to rate the workload of information capture at the end of each day, rather than immediately after each data collection moment. This adaptation ensured that teachers were able to complete the rating without significantly disrupting their work. Teachers completed as few as one or as many as 22 rating forms for any given activity depending on the number of days they performed the activity and their own compliance rates with the experimental protocol. All of the calculations were normalized for a standard 100 point scale regardless of the number of rating forms completed per teacher per activity.

Any task can be evaluated in terms of 6 task scales
FR – Frustration level
How insecure, discouraged, irritated, stressed, and annoyed were you?
EF – Effort
How hard did you have to work to accomplish your level of performance?
OP – Own Performance (based on satisfaction with performance)
How successful were you in accomplishing what you were asked to do?
TD – Temporal Demand
How hurried or rushed was the pace of the task?
PD – Physical Demand
How physically demanding was the task?
MD – Mental Demand
How mentally demanding was the task?

The tally of each task includes calculation the relative weights of these 6 areas. The tally of relative weights involves comparing the 15 possible task pairings and determining which of the 2 is a greater source of workload variation when performing the task. This is based on paired combinations, or (6 * 5) / 2 =
15 combinations with each task scale listed 5 times. Significantly, I requested that the teachers do these comparative ratings once weekly on the premise that they would not change frequently. In some cases, this choice meant a teacher would only complete one comparison in the course of the activity. In other cases, a teacher might complete as many as five. In all of the cases in which multiple comparative rating forms were completed, the scores were the exact same across all of those forms, thereby allowing me to combine all of the data into one large calculation.

The weight for each task scale is the number of pairs for which it was considered more important. Thus, each task scale may appear from 0 to 5 times.

Each rating scale in performing the task is then rated using a visual analogue scale (VAS) scored from 0 to 100 with ends anchored as:

(1) mental demand (MD) from low to high
(2) physical demand (PD) from low to high
(3) temporal demand (TD) from low to high
(4) own performance (OP) from excellent to poor*
(5) effort (EF) from low to high
(6) frustration level (FL) from low to high

* In this case, I calculated inverted the scale presented to the teachers, because all of the scales on their sheets were from low to high. For example, a rating of 15 (fairly confident in performance) would be calculated as a 5 to adjust to the excellent to poor scale standard to the NASA-TLX standard algorithm.

For each rating scale the product of each weighting and rating is then calculated.

Product for each rating scale = (weight from 0 to 5) * (rating from 0 to 100)
Overall sum for the rating scales = SUM(products for each rating scale)
Mean weighted workload (WWL) score = (overall sum for rating scales) / (total sum of weights)

Obviously, the higher the mean weighted workload score the greater the overall demand. Furthermore, a task with a greater mean weighted workload score is more demanding than one with a lower mean weighted workload score.

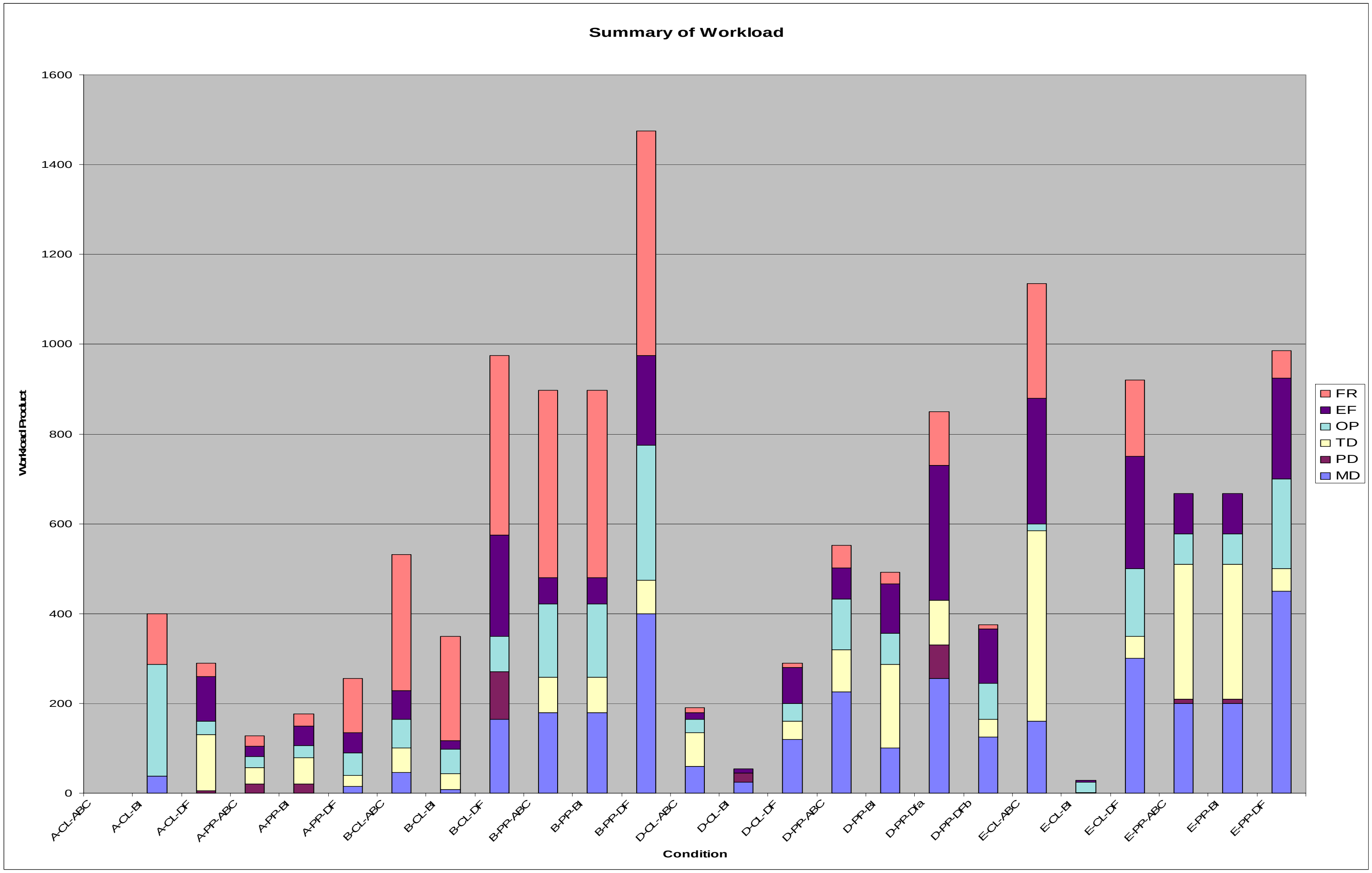
Interpreting the Acronyms and Labels

For the conditions, the first letter is the teacher's participant code. There were 5 teachers (A, B, C, D, E). Teacher C was removed from the study when she began a new job, and so there is no data for her. The second set of letters is the treatment condition, for which PP is Pen and Paper or traditional and CL is CareLog. The third set of letters is the particular task, for which the following is true:

- BI is Basic Information Capture (e.g. that something happened)
- ABC is labeling the Antecedent and Consequence data. In the case of the traditional method, this also includes documenting the time and context. In the case of the CareLog method, the teachers are talking about "labeling" their video data.
- DF is determining the function. In one case, the teacher wanted to further break this activity into tallying (counting incidents) and doing the actual determination and writeup. This distinction is represented on the graphs for determining function.

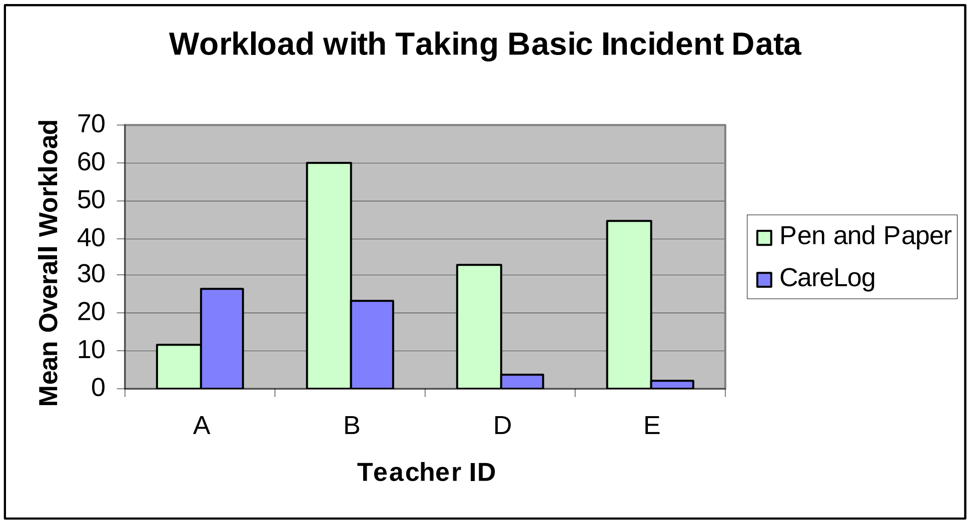
Textual Summary of Graphs to be Presented

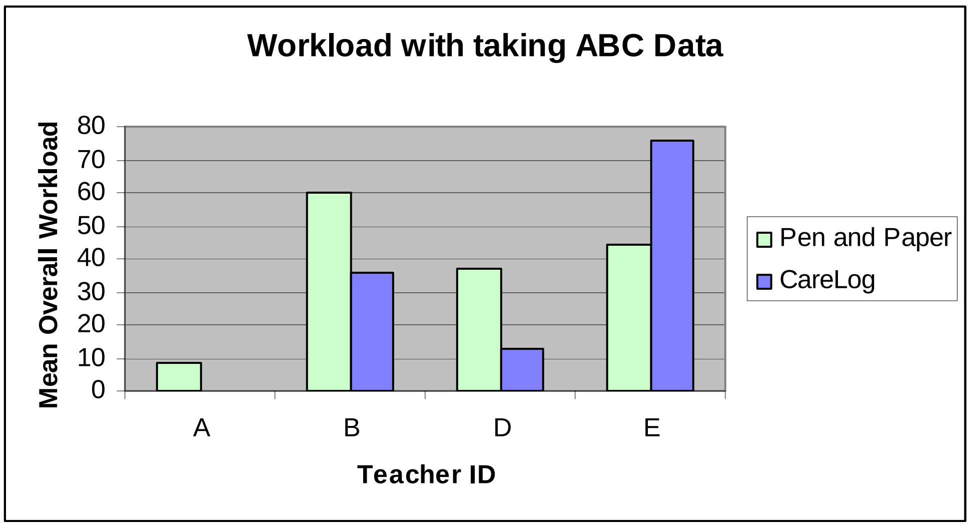
The first graph is an overall representation of workload across all conditions and all teachers. The stacked nature of the graph also shows how that overall workload breaks down for the 6 sub-types of work represented by the NASA-TLX instrument. The second set of graphs shows *average* workload across all 6 sub-types for each of the 4 teachers. Each graph represents a different activity. The third set of graphs further breaks down this information back into the 6 subtypes for each teacher but are still separated by activity.

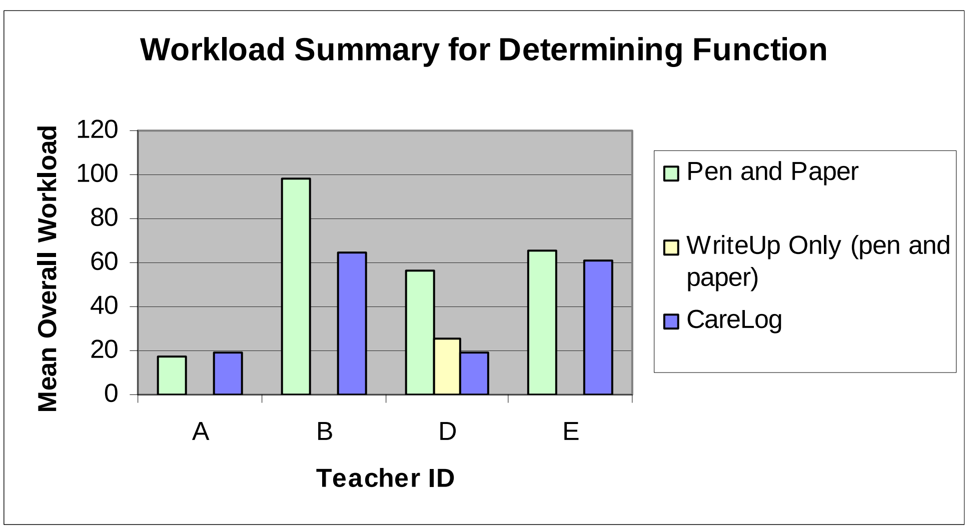


NOTE: A-CL-ABC was not completed by the teacher, hence no scores are presented in this graph. Furthermore, it is also not shown in later graphs for taking ABC data with Teacher A. Unless otherwise, specified all *other* incidents of graphs showing zero values is due to low ratings by teachers, rather than by teachers not completing the ratings.

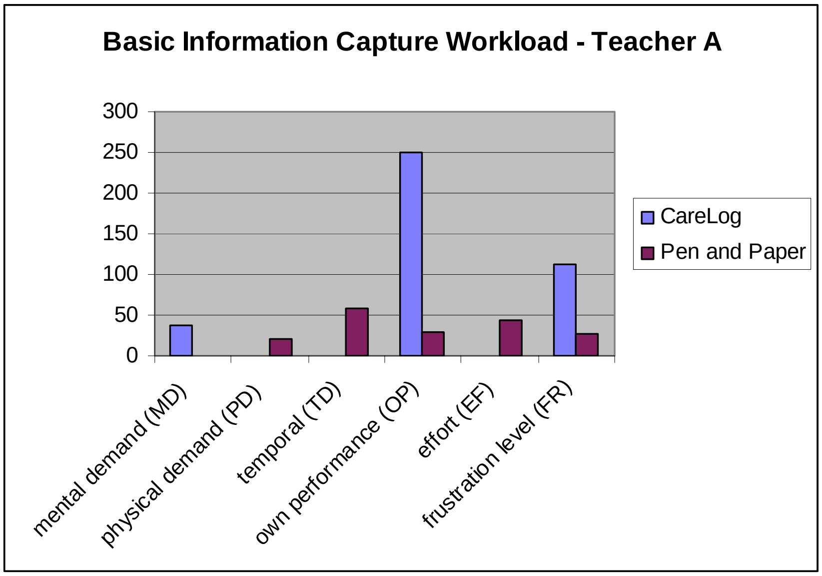
Summary Workloads Across all 4 Teachers



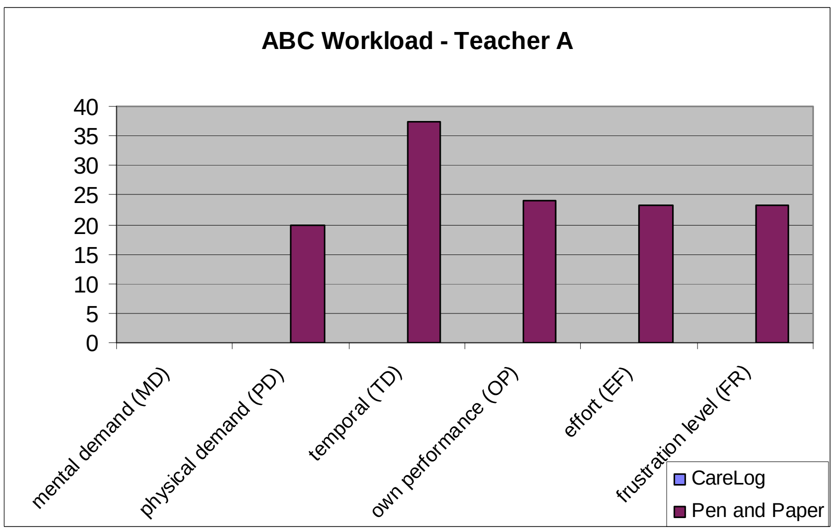




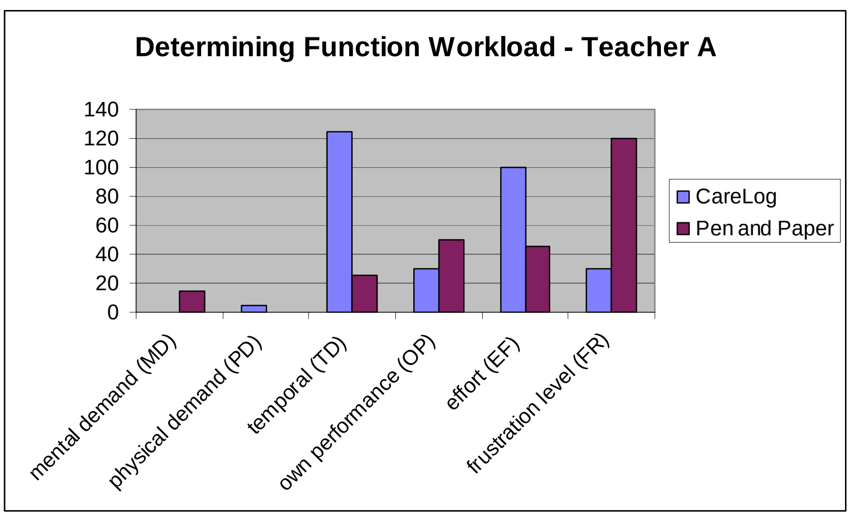
Teacher A



Basic Information Capture Workload - Teacher A
300
250
200
150
100
50
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper

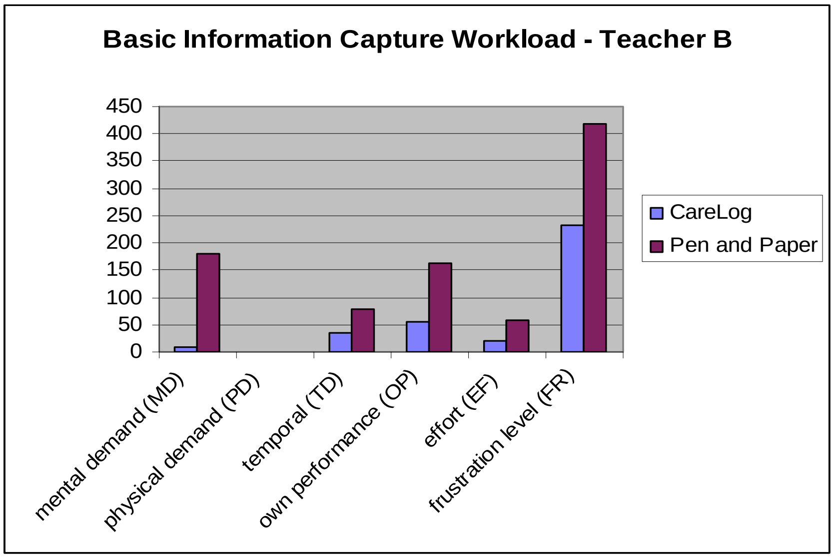


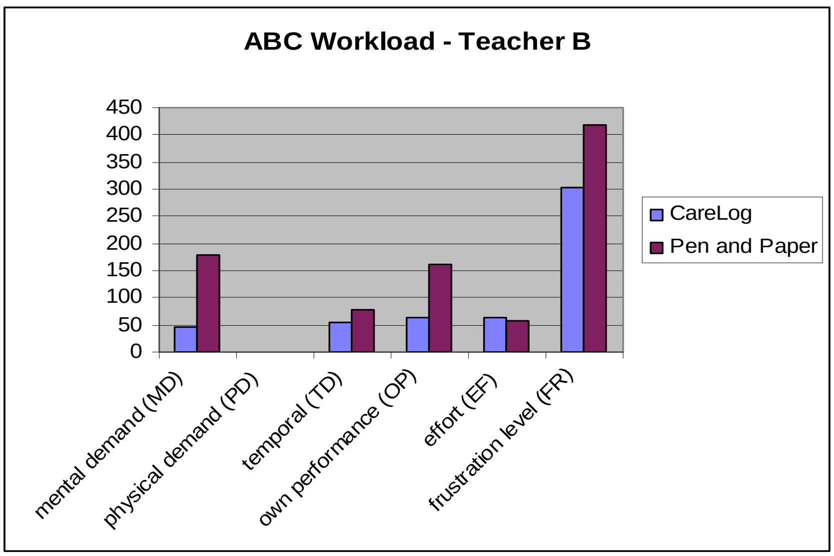
ABC Workload - Teacher A
40
35
30
25
20
15
10
5
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper

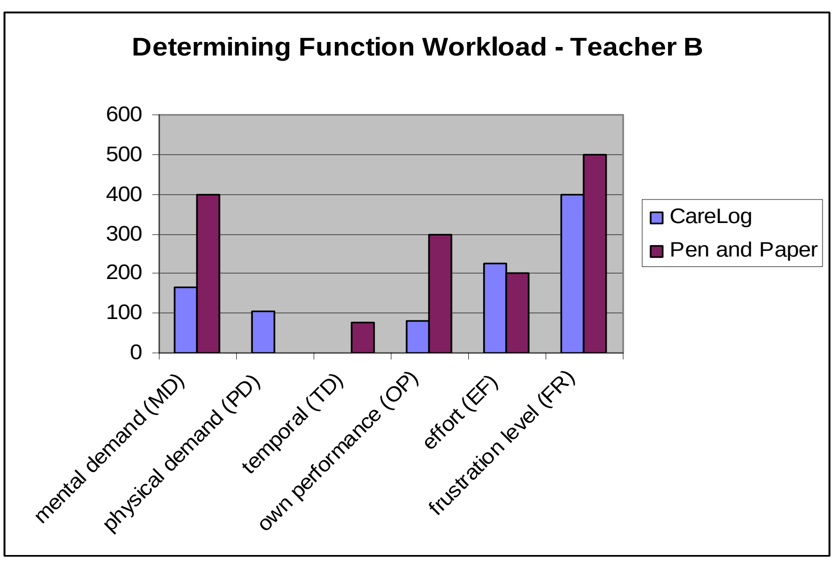


Determining Function Workload - Teacher A
140
120
100
80
60
40
20
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper

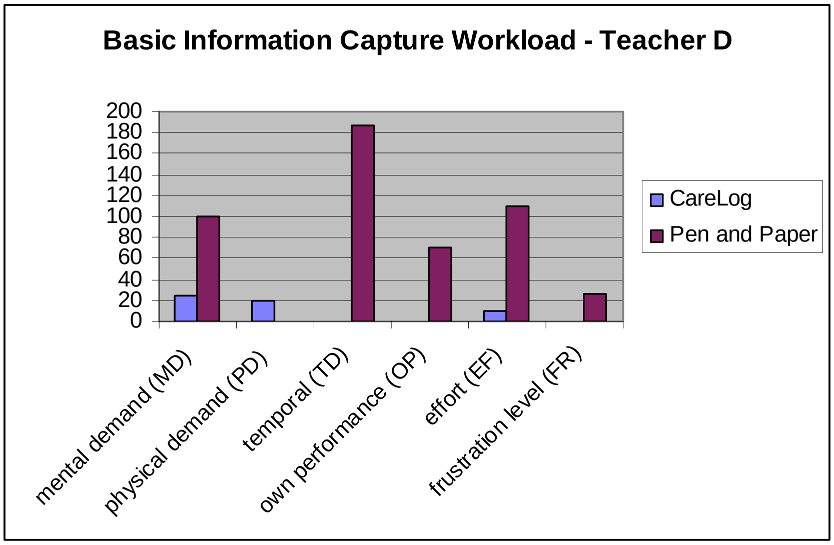
Teacher B


Basic Information Capture Workload - Teacher B
450
400
350
300
250
200
150
100
50
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper

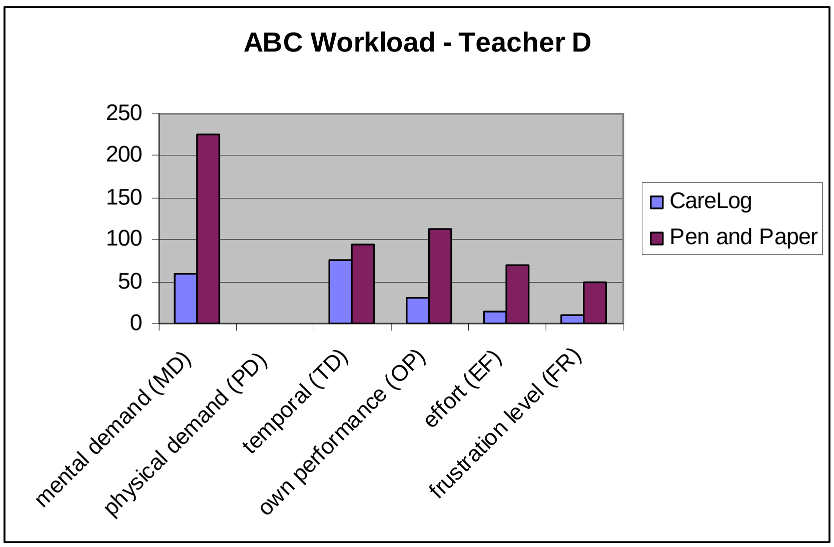

ABC Workload - Teacher B
450
400
350
300
250
200
150
100
50
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper


Determining Function Workload - Teacher B
600
500
400
300
200
100
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper

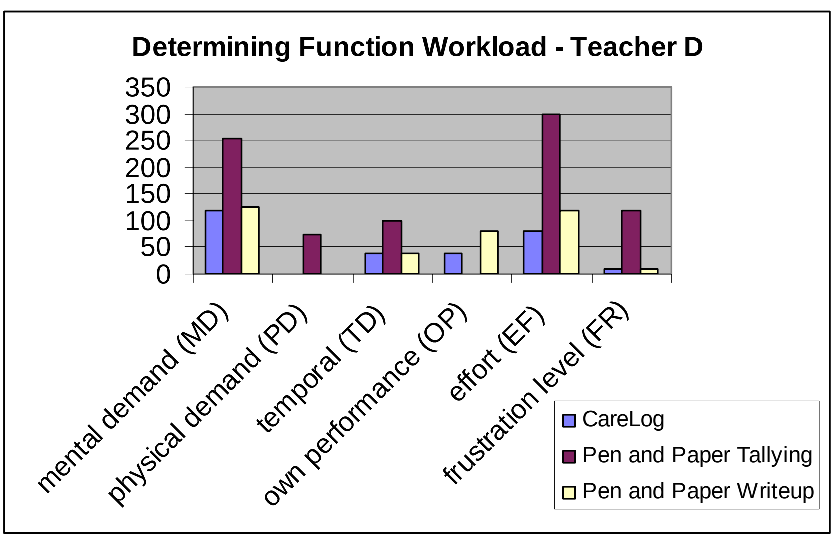
Teacher D



Basic Information Capture Workload - Teacher D
200
180
160
140
120
100
80
60
40
20
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper

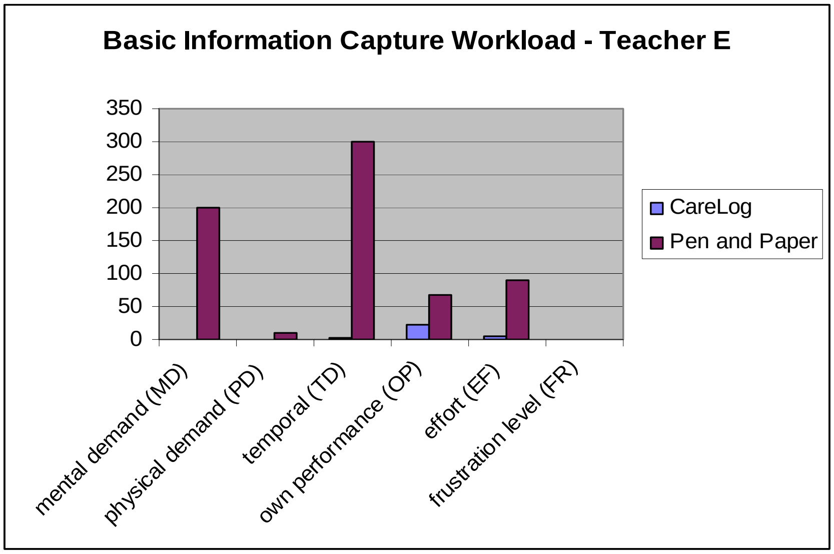


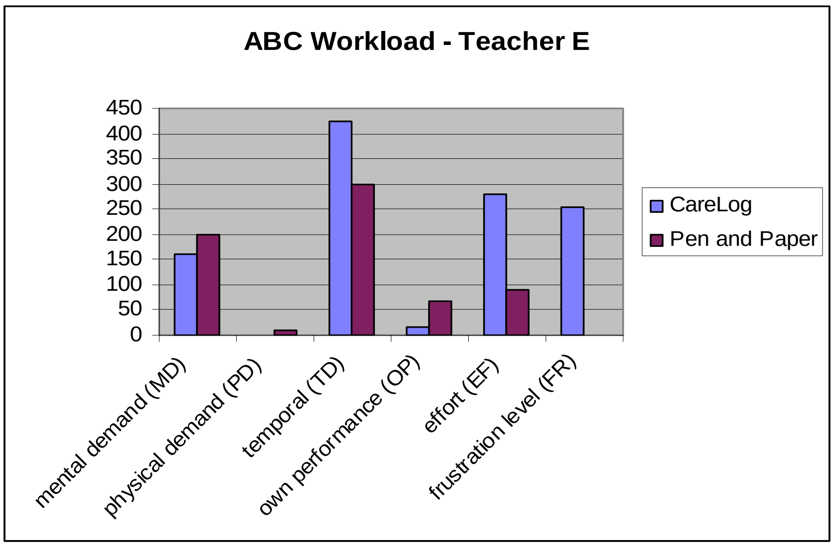
ABC Workload - Teacher D
250
200
150
100
50
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper

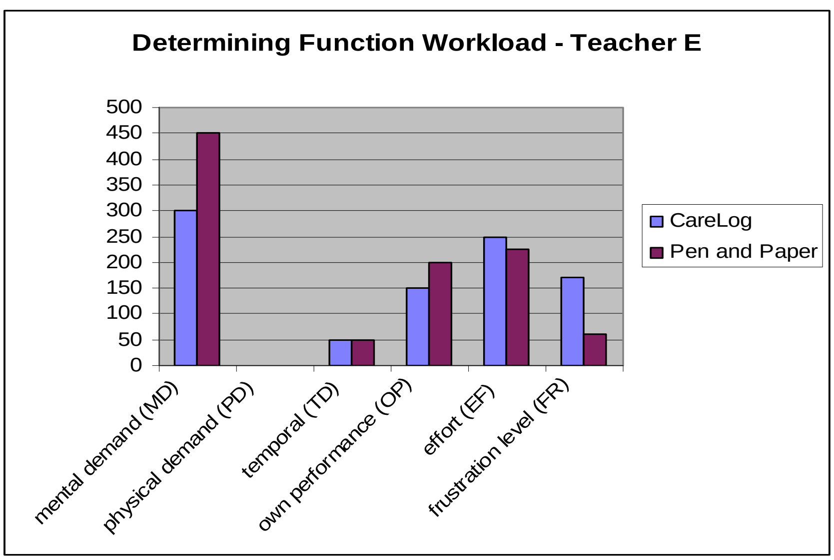


Determining Function Workload - Teacher D
350
300
250
200
150
100
50
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper Tallying
Pen and Paper Writeup

Teacher E


Basic Information Capture Workload - Teacher E
350
300
250
200
150
100
50
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper


ABC Workload - Teacher E
450
400
350
300
250
200
150
100
50
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper


Determining Function Workload - Teacher E
500
450
400
350
300
250
200
150
100
50
0
mental demand (MD)
physical demand (PD)
temporal (TD)
own performance (OP)
effort (EF)
frustration level (FR)
CareLog
Pen and Paper

APPENDIX G: DESCRIPTIONS OF STUDENT BEHAVIOR

Before beginning the FBA for each student, each teacher recorded information about student behavior, including an attempt at an operational definition of that behavior. They recorded this information on note cards that have been transcribed here:

Note Cards from Teachers:

Classroom A:

Derrick

- Behavior(s) <u>Jumping</u> both feet leave floor from an upright position
  <u>Singing</u> Repetitive and Melodic noises made
  <u>Dancing</u> Twirling or jumping with arms raised or pelvic gyrations
- Any combination (or single), in class, out of seat
- Theory: preferred activity, automatic SR+ (in Juane's handwriting, but based on what HH said)

John

- SIB (circled)
- Automatic Reinforcement

Backside → Hit – forcibly brings hand into contact with another
Spit – Expels saliva from mouth
SIB – hits self in face with open palms, making slapping sound

Classroom B:

Doug

- Hitting (starred)
- Attention (theory)
- Definition on backside: Striking another person with an open or closed fist one time)

Ken

- Throwing (starred)
- Sensory (theory)
- Definition on backside: Picking up any object and releasing it through the air

Classroom D:

Lisa

- following directions (starred) – presumably, this means not following directions
- definition on backside: saying no to a specific direction after 2 or more requests.
- theory: control, power

Sam

- behavior noted is "escape"
- there is also a note that says "no previous demands"
- theory: attention, but very unsure of that theory

- behavior definition on backside: running off at any opportunity and not returning

NOTE: This is not the behavior and definition he used when we installed CareLog

Classroom E:
Richard

Target Behavior: Disruption: Any yelling (speaking above conversational tone in an inappropriate setting), making threats to self or others, banging furniture, throwing object (not at people) or destroying materials

Suspected function: escape

Question of hers: When does it settle vs. escalate? (in Juane's handwriting on card after conversation with KC)

Drew

Suspected function: Sensory

Operational definition: Aggression as defined as throwing objects at or kicking a person, or hitting or punching or biting himself or others

Redefining Teacher Operational Definitions:

After working with the teachers throughout the assessment process, I recognized that the operational definitions they documented on these notecards, and the ones they used during the FBA were often not the same. Based on interview and observation data and with the help of an in-school expert and Dr. Juane Heflin, an autism expert from Georgia State University, I created a separate set of operational definitions to be used during our clinical validations and the all day video coding. Although the wording in these definitions is different from those set out by the teachers, both sets of operational definitions are generally trying to describe the same behavior. The one exception to this rule is in the case of Sam, whose teacher changed which behavior to monitor between the original notecard and the installation of CareLog at the beginning of the assessment period.

A - Derrick

Singing: Any melodic noises he makes with his mouth while out of his seat when he should be in his seat. Not considered behavior if singing while walking calmly or if singing while in seat.

Dancing: Dancing out of his seat when he should be in his seat. Not considered behavior if dancing minimally while walking calmly.

Jumping: Jumping out of his seat when he should be in his seat or when he should be walking calmly

A – John

Self Injurious Behavior (SIB): Hitting himself with open palm on the face or head. Hitting himself with closed fist to the face or head.

B - Doug
Hitting self: Hitting his chest with his fingers pointed straight and inwards to his chest
Hitting self-head: Hitting his head with his fist on the front side of his forehead or the top of his head
Hitting others: Hitting any other person (student or staff) with fist or slapping with hand. Significantly, this does NOT include pushing or pulling other people.

B – Ken
Aggression and Disruption: Hitting any other person (student or staff) with fist or slapping with hand or pushing with hands or butting with head. Kicking or stepping on any other person (student or staff) with foot. Throwing (always with objects, not attempts that look like throwing) and clearing objects off surfaces.

D – Lisa
Non-compliance: Three instances of either saying no, expressing no in another way (*e.g.* head turned away, arms crossed in front, putting hair over her face), or simply not doing what she was asked to do in response to any verbal or gestural direction from any staff member. (very important that the request was made)
Disruption: Shouting (above average loud room noise); cursing loudly; Throwing objects (unless at a person); Stomping
Physical Aggression: Throwing objects (at person); Hitting, Kicking, Spitting, Slapping, Pushing (all towards a person – staff or students)

D – Sam
Disruptive Verbal Behavior: Any language that is loud enough to hear and spoken slowly enough to understand that includes the following topics:

- Sex, including both explicit and euphemistic references to sex and to pregnancy
- Drugs, including both references to their use and to them more generally
- Threats of violence to self or others
- Strippers and strip clubs

And/or the following words and phrases (in order or observed appearance during the study):

- hell
- ass
- fuck you
- bitch
- B.I.T.C.H.
- stupid [followed by a name]
- mother fucker
- mother fuckin'
- 'ho
- whore
- I hate your ugly ass
- shut the hell up

- damn
- pussy
- dick
- fag
- faggot
- nigger

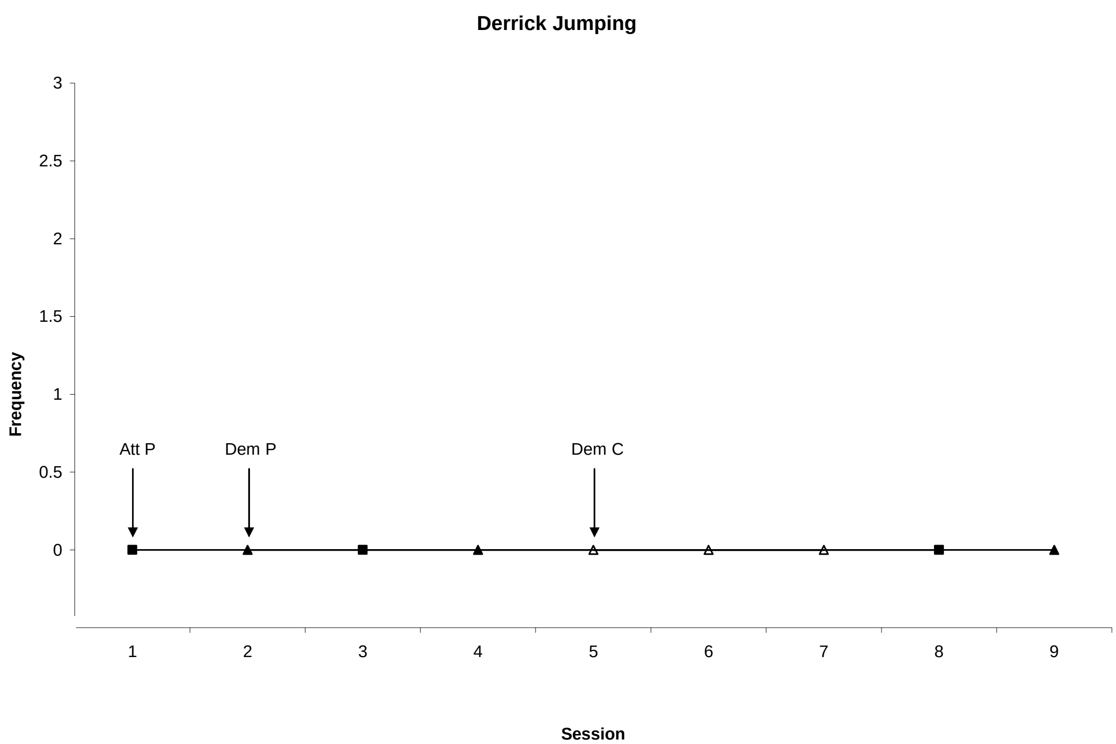
E - Richard
Disruption: Any whining or yelling above conversational tone (for the setting). Throwing of items (including papers, pencils, desks, and other classroom objects), hitting self or others (including any hitting to any body part with any body part or object with enough force to mash a loaf of bread, break chips in a bag, or make a loud noise), attempts to climb out the window, throwing self on ground, banging on walls or ground with fists or open hands.

E – Drew
Hitting Self: Any striking of self with hand more than a few inches from body, generally should be hard enough to leave a red mark if on bare skin or to mash a loaf of bread if struck there rather than his body. These hits are usually to the chest, stomach, or head, but should be considered even if to other parts of the body.
Hitting Others: Any striking of another student or a staff member with hand in any position more than a few inches from the other person at the time of striking. Again, the hit should be hard enough to leave a red mark if on bare skin or to mash a load of bread.

APPENDIX H: FUNCTIONAL BEHAVIOR ANALYSES AND CLINICAL VALIDATION SESSIONS

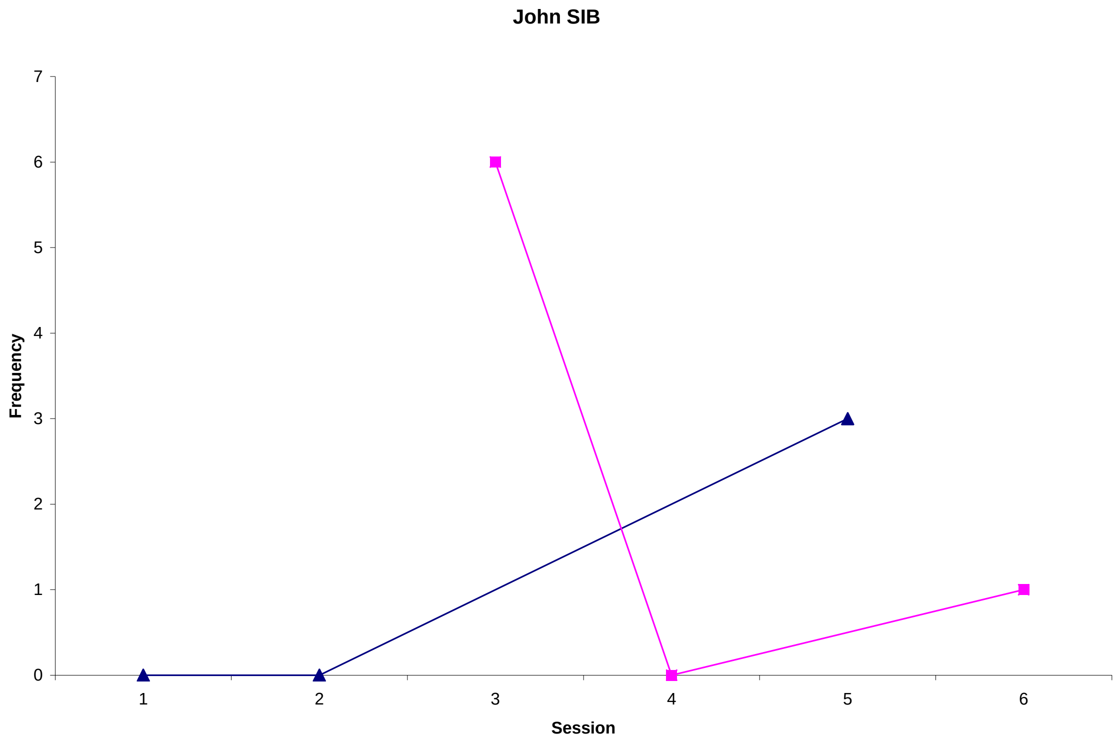
Staff at the school and a professor in special education together conducted clinical validations of the functions determined for seven of the eight enrolled students. These sessions were video-taped and coded by at least two people for reliability. In most cases, the agreement between coders was 100%. The lowest agreements were all above 90%.

Classroom A – Student Derrick – Behavior Jumping
Three conditions were used with Derrick, attention from a particular staff member from his classroom (Att P, filled in square), demand placed on him by that staff member (Dem P, filled in triangle) and demand from a staff member from outside his classroom (Dem C, open triangle). The first two sessions were conducted in the student's classroom, and the others all were conducted in the TASB support room. Each session lasted five minutes. He showed no behavior in any condition and thus is determined to be undifferentiated in behavior based on the clinical validation.



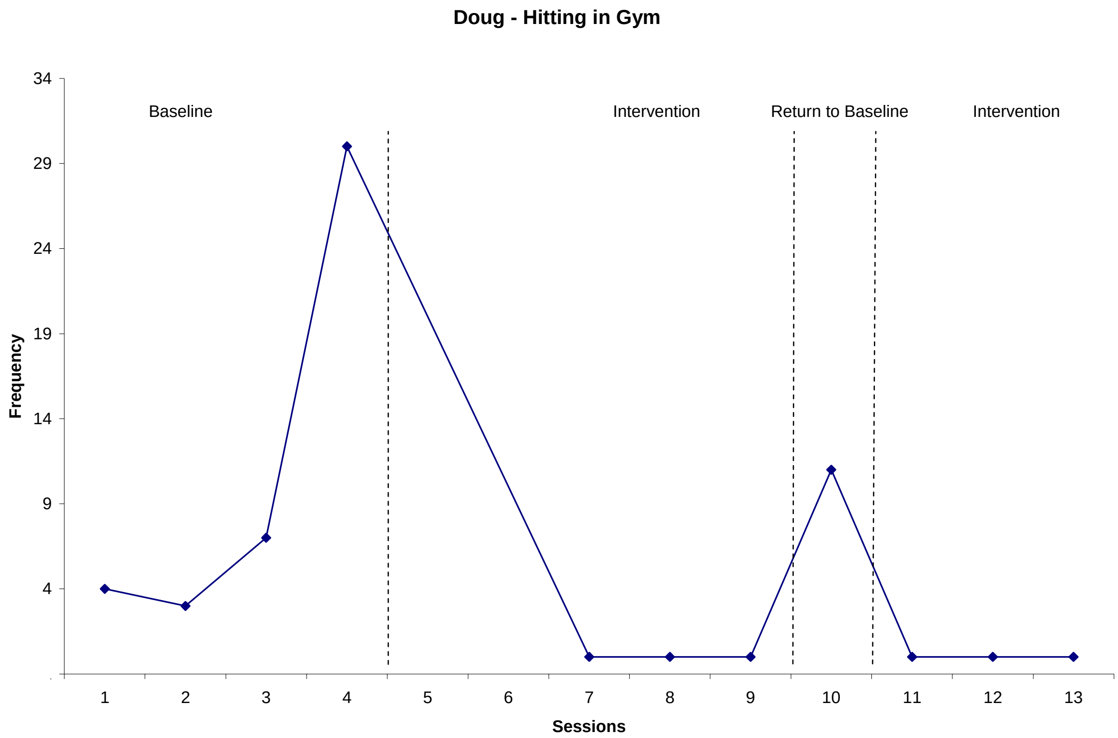
Classroom A – Student John – Behavior Self-Injury, hitting self in head

Two conditions were used with John, with pillow (square) and without (triangle). In all conditions, he was left alone except when trying to leave the room. No pattern can be observed in John's data. Thus, he also demonstrates undifferentiated behavior by clinical validation.



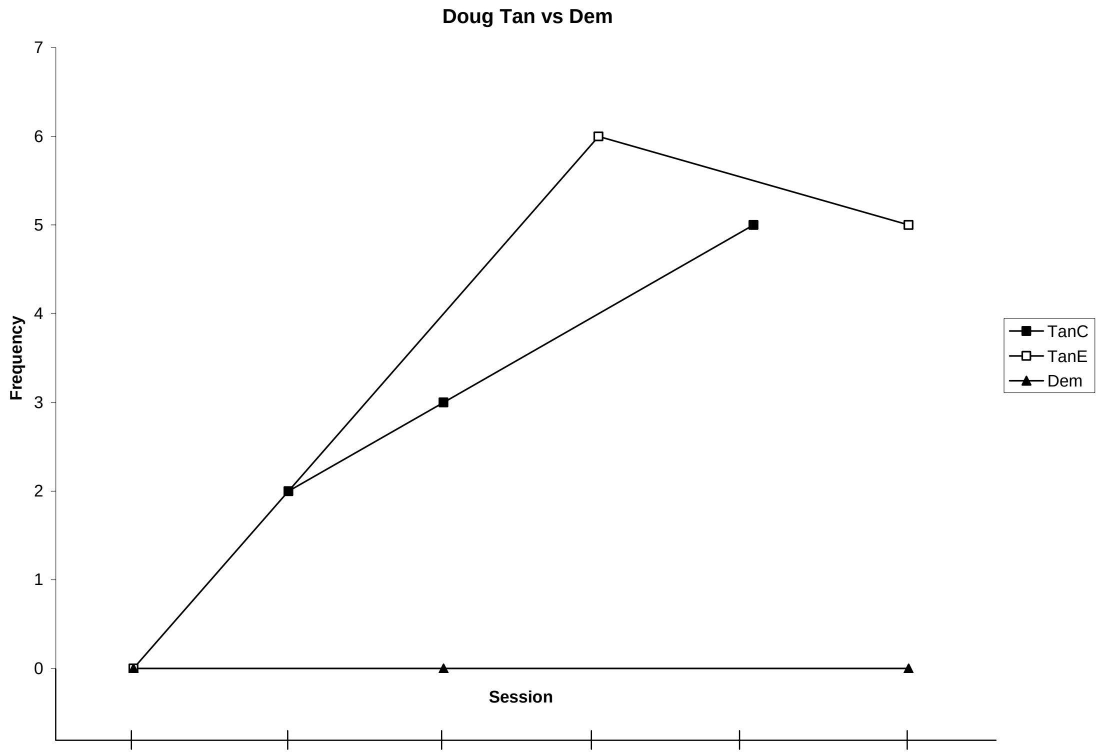
Classroom B – Student Doug – Behavior Hitting in Gym

Teacher B determined two functions for Doug's behavior dependant on the context of that behavior. In gym class, she hypothesized that Doug was attempting to escape gym and had already introduce an intervention that was working when it came time for the clinical validation. Thus, the validation occurred using an ABAB design with A being baseline and B being her intervention. The values for the original baseline frequency were taken from the all day recordings done as part of the study. The remaining three conditions were created in the gym with the classroom and TASB staff and validated by video tape. The pattern observed in Doug's data coupled with the intervention indicate an escape function as hypothesized.



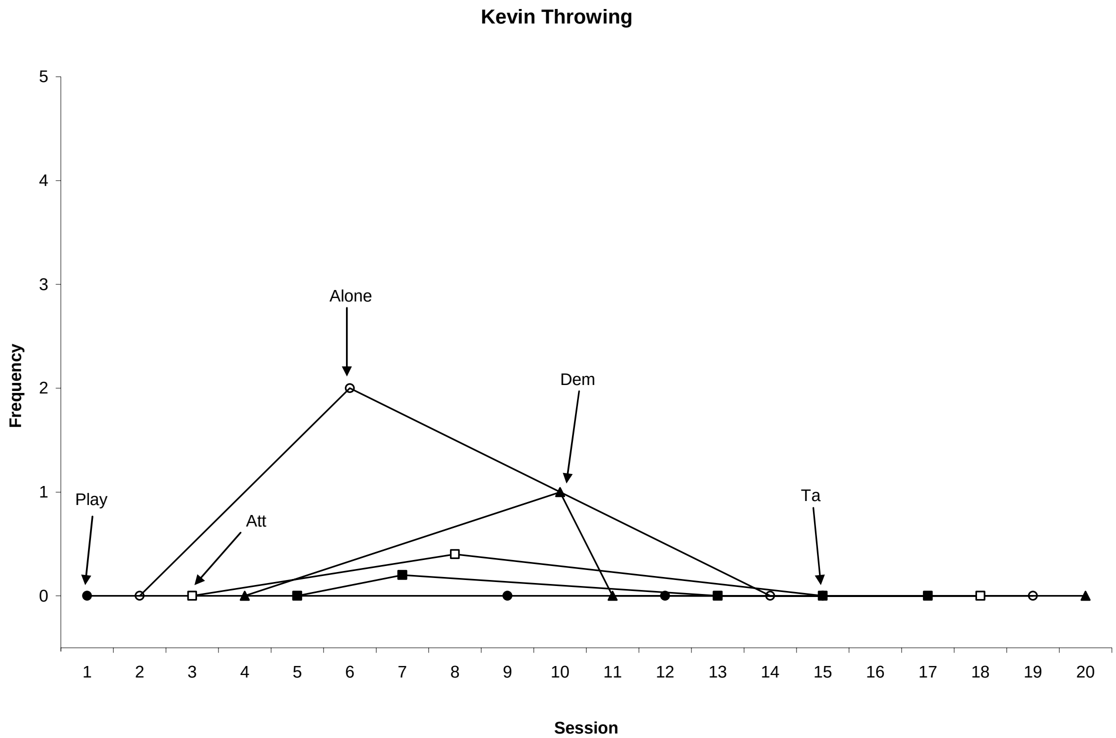
Classroom B – Student Doug – Behavior Hitting in Classroom

For Doug's classroom behavior, his teacher determined that his function was tangible. Thus, clinical validation sessions included tangible with his classroom teacher (Tan E), tangible with staff from TASB (tan E) and demand (the default setting for classrooms). Each session was five minutes long, and the tangible object of interest was a radio. Between sessions, Doug was allowed to play. The pattern observed in Doug's data clearly indicates a tangible function.



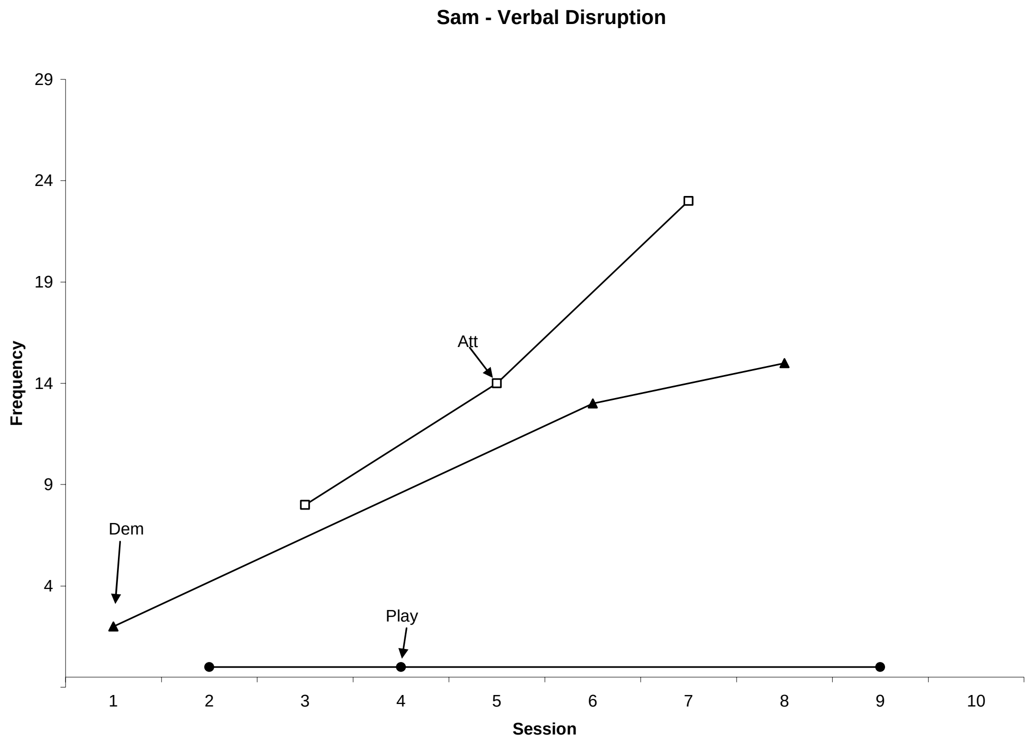
Classroom B – Student Kevin – Behavior Throwing

Across twelve different sessions with Kevin during the clinical validations associated with this study, he showed no behavior, even when those sessions were increased in length. Thus, I also include separate clinical analysis data conducted outside of this study that was shared as part of the validation process. In these sessions, all five potential conditions were applied: Play, Attention, Alone, Demand, and Tangible. No patterns could be discerned from this data. Thus, this information coupled with Kevin's lack of behavior during our study indicate that his behavior is undifferentiated.



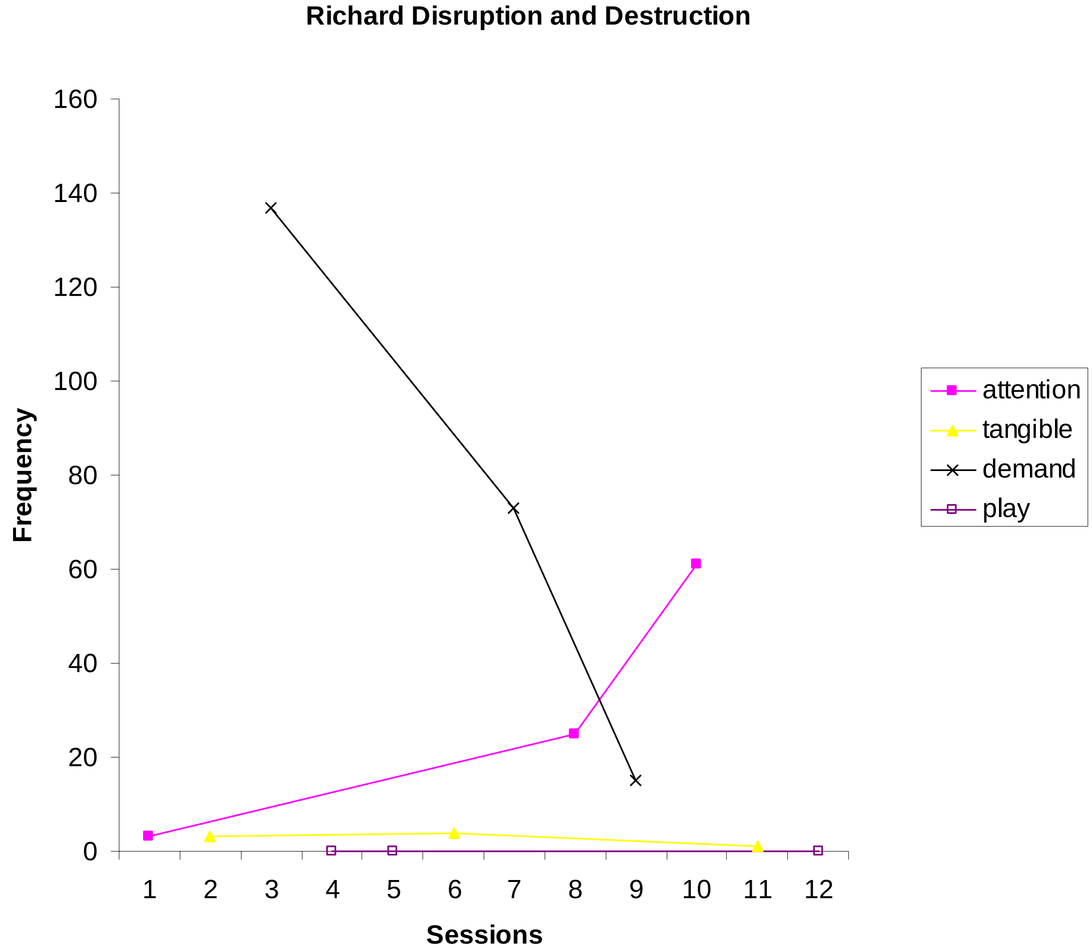
Classroom D – Student Sam – Behavior Inappropriate Verbal Disruptions and Outbursts

Analysis of Sam's behavior included testing of three conditions all in the TASB support room: Demand (dem), Attention (Att), and Play, as a control. Each session was five minutes in length. Between sessions, particularly those that showed high amounts of behavior, we used standard protocols to calm him and then gave him a break. The patterns in Sam's behavior indicate a strong attention function and a lesser demand function.



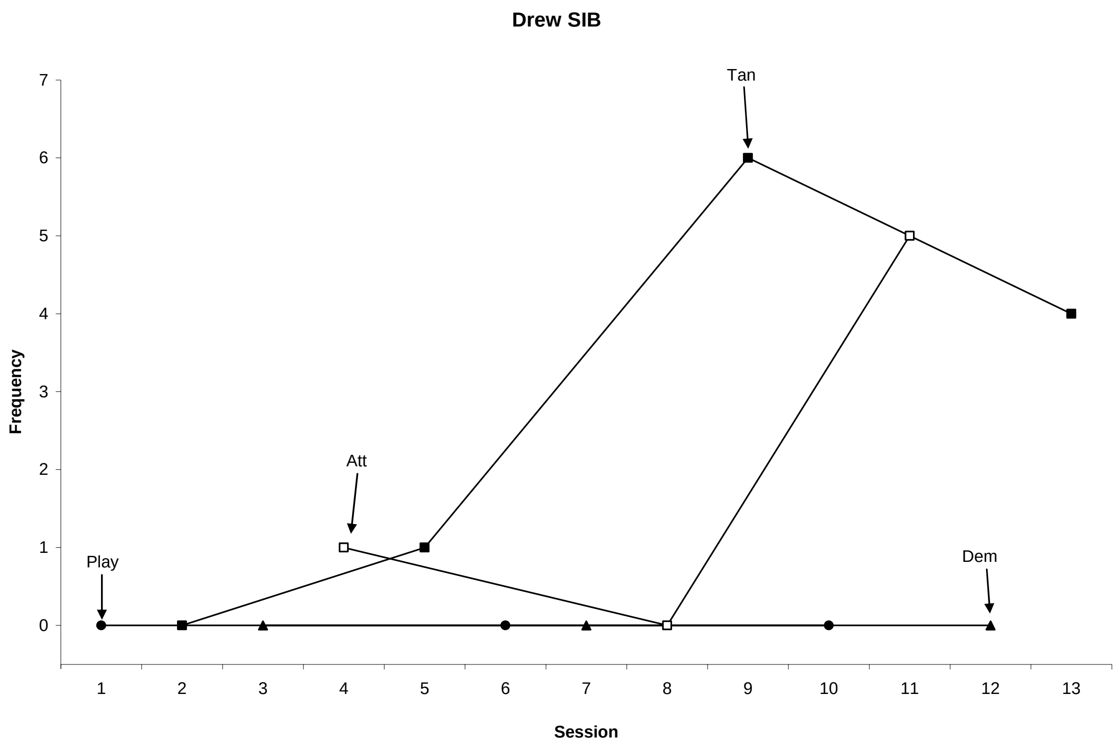
Classroom E – Student Richard – Behavior Disruption and Destruction

Because Richard's teacher hypothesized both attention and demand as part of her description of his function, and others had commented on a tangible component, Richard's clinical analysis included four conditions with play serving as the control condition. Each session lasted five minutes. The stable upward trend of the attention condition indicates an attention function. Although the first demand session resulted in extremely high frequency, the stable downward trend for this condition indicates that it is not likely to be the function. More likely, that particular condition was an anomaly in the data. All sessions were conducted in the TASB support room. In the cases of high frequency, standard protocols were used to calm the student and give him a break before another condition.



Classroom E – Student Drew – Behavior Self-Injurious Behavior

Drew's teacher assessed that his self-injurious behavior (SIB) was the result of a tangible (Tan) and demand (Dem) based function. She had some inclinations that there might be an attention (Att) component as well but was less confident. Thus, Drew's analysis included four conditions, with play serving as the control condition. Each session lasted ten minutes. Half were conducted in the TASB support room, and half were conducted in his classroom. The patterns in his data indicate both tangible and attention functions with no behavior observed in the demand conditions.



APPENDIX I: ANONYMOUS BUFFERWARE SURVEY INSTRUMENTS

I.1 BufferWare Survey – First Deployment

Project Description
BufferWare is a system that allows you to save the last few minutes of audio and video when you least expected you needed or wanted to save it. The system was installed in October in the space near the window of the third floor common area here in TSRB.

Please take 5-10 minutes to complete this* anonymous research *survey about BufferWare.

Instructions *You can return this survey to the drop box in 330, in the mailbox of Giovanni Iachello, Gillian Hayes, or Erika Shehan, or slid under the door of 329 (Gregory Abowd). This survey is **anonymous** and **confidential**. **There are no right answers.** We want to know what you think of the system, and how you think it works. If you have any questions about your rights as a research subject contact Melanie Clark, Compliance Administrator at 404-894-6942.*

Background Questions:

1. On which floor of TSRB do you spend the most time? (circle one) 1 2 3 4 5

2. How much time do you spend in the TSRB?

A little			Some			A lot
1	2	3	4	5	6	7
Less than an hour a day on average			4 to 6 hours, 3 days a week			More than 8 hours a day and some weekends

3. How much time do you spend in the **common areas near the stairwells** in TSRB?

A little			Some			A lot
1	2	3	4	5	6	7
Less than 10 minutes a day on average			Some time most days, around 30 minutes a day			Nearly every day, more than 1 hour a day

4. How much time did you spend in the common area near to the window in TSRB, 3rd floor ***before* BufferWare** was there?

A little			Some			A lot
1	2	3	4	5	6	7
Less than 10 minutes a day on average			Some time most days, around 30 minutes a day			Nearly every day, more than 1 hour a day

5. What did you do there? (circle all that apply or write your own)

Work/Read Meetings Eat Phone Calls Wait / Watch Cars Other:____________

6. How much time do you spend in the common area near to the window in TSRB, 3rd floor **now that BufferWare is there?**

A little			Some			A lot
1	2	3	4	5	6	7
Less than 10 minutes a day on average			Some time most days, around 30 minutes a day			Nearly every day, more than 1 hour a day

7. What do you do there **now**? (circle all that apply or write your own)

Work/Read Meetings Eat Phone Calls Wait / Watch Cars Other:____________

8. Please **circle the item** which best approximates your level of agreement with the following statements.

Consumers have lost all control over how personal information is collected and used by companies.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
Most businesses handle the personal information they collect about consumers in a proper and confidential way.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
Existing laws and organizational practices provide a reasonable level of protection for consumer privacy today.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
I like having my picture taken.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
I like hearing my voice on tape recordings.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*

BufferWare Questions:

9. What does the **blue line mean** to you? (In the questions below, if you don't know, just write "don't know")

10. How far is the **range of the microphone** on the table?

11. In addition to you, can anyone **look at the camera feed** while BufferWare is running and you are there? If so, who?

12. When BufferWare is running, **how long is audio/video available for archival** after it happens?

13. How long would you like the audio/video to be available for archival after it happens?

14. In addition to you, **who can look at video clips you archive (if anyone)?**

15. Have you ever **tried to use BufferWare?** (circle) Yes No

If yes:

16. How **usable** was the table-top archival interface?	Very Hard 1	2	3	Average 4	5	6	Very Easy 7

17. Did you go back and **view the recording**? (circle) Yes No

18. If yes, how **usable** was the viewing interface?	Very Hard 1	2	3	Average 4	5	6	Very Easy 7

19. Please leave us any other **comments:**

***Optional* Contact Information** (If you want to be contacted for a potential interview or want the researchers to know who you are)

Name:____

Email:____

Thanks! Gillian, Giovanni, and Erika http://www.carelog.org/bufferware for more info.

I.2 BufferWare Survey – Second Deployment

Project Description
BufferWare is a system that allows you to save the last few minutes of audio and video when you least expected you needed or wanted to save it. The system was installed last year in the space near the window of the third floor common area here in TSRB and then updated this fall to make it easier and better to use.

Please take 5-10 minutes to complete this* anonymous research *survey about BufferWare.

Instructions *You can return this survey to the drop box in 330, in the mailbox of Gillian Hayes or Erika Shehan, or slid under the door of 329 (Gregory Abowd). This survey is* ***anonymous*** *and* ***confidential****.* ***There are no right answers.*** *We want to know what you think of the system, and how you think it works. If you have any questions about your rights as a research subject contact Melanie Clark, Compliance Administrator at 404-894-6942.*

1. On which floor of TSRB do you spend the most time? (circle one) 1 2 3 4 5

2. How much time do you spend in the TSRB?

A little			Some			A lot
1	2	3	4	5	6	7
Less than an hour a day on average			4 to 6 hours, 3 days a week			More than 8 hours a day and some weekends

3. How much time do you spend in the **common areas near the stairwells** in TSRB?

A little			Some			A lot
1	2	3	4	5	6	7
Less than 10 minutes a day on average			Some time most days, around 30 minutes a day			Nearly every day, more than 1 hour a day

4. If you were at TSRB, **how much time** did you spend in the common area near to the window in TSRB, 3rd floor ***before*** **BufferWare** was there?

A little			Some			A lot
1	2	3	4	5	6	7
Less than 10 minutes a day on average			Some time most days, around 30 minutes a day			Nearly every day, more than 1 hour a day

5. What did you do there? (circle all that apply or write your own)

Work/Read Meetings Eat Phone Calls Wait / Watch Cars
Other:____________

6. If you were at TSRB, **how much time** did you spend in the common area near to the window in TSRB, 3rd floor **when the *first* BufferWare** was there?

A little			Some			A lot
1	2	3	4	5	6	7
Less than 10 minutes a day on average			Some time most days, around 30 minutes a day			Nearly every day, more than 1 hour a day

7. What did you do there? (circle all that apply or write your own)

Work/Read Meetings Eat Phone Calls Wait / Watch Cars
Other:____________

8. How much time did you spend in the common area near to the window in TSRB, 3rd floor **when the second version of BufferWare was there?**

A little			Some			A lot
1	2	3	4	5	6	7
Less than 10 minutes a day on average			Some time most days, around 30 minutes a day			Nearly every day, more than 1 hour a day

9. What do you do there **now**? (circle all that apply or write your own)

Work/Read Meetings Eat Phone Calls Wait / Watch Cars
Other:____________

10. Please indicate how much these different factors affect how much time you spend at/near the BufferWare table:

	A little			Some			A lot
Closeness to the window	1	2	3	4	5	6	7
Physical comfort of sitting at the table	1	2	3	4	5	6	7
Concern about ruining the technology at the table	1	2	3	4	5	6	7
Concern about being recorded	1	2	3	4	5	6	7
Not wanting to be in an experiment	1	2	3	4	5	6	7
Wanting to help with an experiment	1	2	3	4	5	6	7
Using the clear boards	1	2	3	4	5	6	7
Wanting to use the BufferWare service	1	2	3	4	5	6	7
Curiosity	1	2	3	4	5	6	7

Please list anything else that affected your choices to sit there or not:

11. Please **circle the item** which best approximates your level of agreement with the following statements.

Consumers have lost all control over how personal information is collected and used by companies.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
Most businesses handle the personal information they collect about consumers in a proper and confidential way.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*

Existing laws and organizational practices provide a reasonable level of protection for consumer privacy today.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
I like having my picture taken.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*
I like hearing my voice on tape recordings.	*Strongly Disagree*	*Somewhat Disagree*	*Somewhat Agree*	*Strongly Agree*

12. Did you fill out the first BufferWare survey? ______ Yes ________No

13. Were you in the TSRB last year when BufferWare was running? ______ Yes ________No

14. If yes, describe any differences about the space with the old BufferWare and the new one?

15. **a)**Describe what you think is happening in the space for BufferWare using your own thoughts, things you learned from the signs, the webpage, or any other sources:

b) How did you determine your answer?

16. How far is the **range of the microphone** on the table?

17. In addition to you, can anyone **look at the live camera feed** while BufferWare is running and you are there?
If so, who?

18. When BufferWare is running, **how long is audio/video available** to be saved?

19. How long **would you like the audio/video to be available** to be saved?

20. In addition to you, **who can look at video clips you archive (if anyone)?**

21. Have you ever **tried to use BufferWare?** (circle) Yes No

If yes:

22. How **usable** was the table-top archival interface?

Very Hard			Average			Very Easy
1	2	3	4	5	6	7

23. Did you go back and **view the recording**? (circle) Yes No

24. If yes, how **usable** was the viewing interface?

Very Hard			Average			Very Easy
1	2	3	4	5	6	7

25. Please leave us any other **comments:**

Optional **Contact Information** (If you are willing to be contacted for a potential interview or want the researchers to know who you are)

Name:____

Email:____

Thanks! Erika, Giovanni, Gillian, Gregory, Khai, and Shwetak
http://www.carelog.org/bufferware for more info.

APPENDIX J: BUFFERWARE SURVEY CORRELATION TABLES

- For the first three elements, respondents chose on a scale of 1 (a little) to 7 (every day), how much they use the BufferWare space: PREBW = Pre-BufferWare condition; BW1 = first deployment; BW2 = second deployment
- For the fourth element, USEBW, respondants answered whether they had used BufferWare (1 for yes, 0 for no in my coding)
- For the remaining elements, respondants chose on a scale of 1 to 7, how much particular features affected their use of the space.

WINDOW – assessment of how much proximity to the window affected choice to sit in space
PHYSICAL – assessment of how much the physical comfort of the table area affected choice to sit in space
RUINTECH – assessment of how much the risk of running the technology affected choice to sit in space
RECORDIN – assessment of how much concerns about being recorded affected choice to sit in space
NOTEXP – assessment of how much not wanting to be in an experiment affected choice to sit in space
WANTEXP – assessment of how much wanting to be in an experiment affected choice to sit in space
CLEARBOA – assessment of how much use of the clearboards affected choice to sit in space
CURIOSIT – assessment of how much curiosity about BufferWare affected choice to sit in space

I ran a standard two-tailed Pearson correlation on the data.
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

		PREBW	BW1	BW2	USEBW	WINDOW	PHYSICAL	RUINTECH	RECORDIN	NOTEXP	WANTEXP	CLEARBOA	CURIOSIT
PREBW	Pearson Correlation	1	.491(**)	.502	-.512	.218	-.134	-.157	.601	.386	-.416	-.390	-.109
	Sig. (2-tailed)	.	.007	.096	.107	.520	.695	.645	.050	.241	.203	.235	.749
	N	31	29	12	11	11	11	11	11	11	11	11	11
BW1	Pearson Correlation	.491(**)	1	.697(*)	-.353	-.557	-.066	-.354	.581	.251	-.381	-.101	.005
	Sig. (2-tailed)	.007	.	.017	.317	.095	.857	.316	.078	.485	.277	.782	.990
	N	29	30	11	10	10	10	10	10	10	10	10	10
BW2	Pearson Correlation	.502	.697(*)	1	-.459	-.029	.059	-.409	.528	.014	-.701(*)	-.243	-.173
	Sig. (2-tailed)	.096	.017	.	.134	.928	.856	.187	.077	.965	.011	.447	.591
	N	12	11	13	12	12	12	12	12	12	12	12	12

USEBW	Pearson Correlation	-.512	-.353	-.459	1	.184	.178	.576	-.387	-.297	.575	.659(*)	.646(*)
	Sig. (2-tailed)	.107	.317	.134	.	.567	.580	.050	.214	.349	.051	.020	.023
	N	11	10	12	12	12	12	12	12	12	12	12	12
WINDOW	Pearson Correlation	.218	-.557	-.029	.184	1	.182	.276	-.271	-.213	.067	.247	.436
	Sig. (2-tailed)	.520	.095	.928	.567	.	.572	.386	.395	.507	.836	.439	.156
	N	11	10	12	12	12	12	12	12	12	12	12	12
PHYSICAL	Pearson Correlation	-.134	-.066	.059	.178	.182	1	-.077	-.510	-.039	-.192	.184	.294
	Sig. (2-tailed)	.695	.857	.856	.580	.572	.	.813	.090	.904	.550	.566	.354
	N	11	10	12	12	12	12	12	12	12	12	12	12
RUINTECH	Pearson Correlation	-.157	-.354	-.409	.576	.276	-.077	1	-.245	-.198	.531	.492	.427
	Sig. (2-tailed)	.645	.316	.187	.050	.386	.813	.	.443	.538	.076	.104	.166
	N	11	10	12	12	12	12	12	12	12	12	12	12
RECORDIN	Pearson Correlation	.601	.581	.528	-.387	-.271	-.510	-.245	1	.584(*)	-.319	-.359	-.399
	Sig. (2-tailed)	.050	.078	.077	.214	.395	.090	.443	.	.046	.312	.251	.199
	N	11	10	12	12	12	12	12	12	12	12	12	12
NOTEXP	Pearson Correlation	.386	.251	.014	-.297	-.213	-.039	-.198	.584(*)	1	-.151	-.275	-.351
	Sig. (2-tailed)	.241	.485	.965	.349	.507	.904	.538	.046	.	.639	.387	.263
	N	11	10	12	12	12	12	12	12	12	12	12	12
WANTEXP	Pearson Correlation	-.416	-.381	-.701(*)	.575	.067	-.192	.531	-.319	-.151	1	.444	.471
	Sig. (2-tailed)	.203	.277	.011	.051	.836	.550	.076	.312	.639	.	.148	.123
	N	11	10	12	12	12	12	12	12	12	12	12	12
CLEARBOA	Pearson Correlation	-.390	-.101	-.243	.659(*)	.247	.184	.492	-.359	-.275	.444	1	.528
	Sig. (2-tailed)	.235	.782	.447	.020	.439	.566	.104	.251	.387	.148	.	.078

	N	11	10	12	12	12	12	12	12	12	12	12	12
CURIOSIT	Pearson Correlation	-.109	.005	-.173	.646(*)	.436	.294	.427	-.399	-.351	.471	.528	1
	Sig. (2-tailed)	.749	.990	.591	.023	.156	.354	.166	.199	.263	.123	.078	.
	N	11	10	12	12	12	12	12	12	12	12	12	12

In the second correlation test, I examined whether space use correlated to statements adapted from the Westin privacy survey and comfort with pictures and audio recording in general.

- For the first three elements, respondents chose on a scale of 1 (a little) to 7 (every day), how much they use the BufferWare space: PREBW = Pre-BufferWare condition; BW1 = first deployment; BW2 = second deployment
- The remaining five elements correspond to agreement on a scale of 1 (strongly disagree) to 4 (strongly agree) with the following statements:
  LOSTCONT: Consumers have lost all control over how personal information is collected and used by companies.
  BUSHANDL: Most businesses handle the personal information they collect about consumers in a proper and confidential way.
  EXISTLAW: Existing laws and organizational practices provide a reasonable level of protection for consumer privacy today.
  LIKEPIC: I like having my picture taken.
  LIKEAUDI: I like hearing my voice on tape recordings.

I ran a standard two-tailed Pearson correlation on the data.

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

		PREBW	BW1	BW2	LOSTCONT	BUSHANDL	EXISTLAW	LIKEPIC	LIKEAUDI
PREBW	Pearson Correlation	1	.491(**)	.502	.024	-.426(*)	-.067	-.063	-.106
	Sig. (2-tailed)	.	.007	.096	.898	.019	.725	.740	.576
	N	31	29	12	31	30	30	30	30
BW1	Pearson Correlation	.491(**)	1	.697(*)	-.021	-.371(*)	-.083	.029	.013
	Sig. (2-tailed)	.007	.	.017	.912	.048	.669	.880	.948
	N	29	30	11	30	29	29	29	29
BW2	Pearson Correlation	.502	.697(*)	1	.365	-.148	-.144	.483	.257
	Sig. (2-tailed)	.096	.017	.	.220	.630	.638	.094	.396

	N	12	11	13	13	13	13	13	13
LOSTCONT	Pearson Correlation	.024	-.021	.365	1	-.386(*)	.157	.287	.057
	Sig. (2-tailed)	.898	.912	.220	.	.032	.400	.117	.760
	N	31	30	13	32	31	31	31	31
BUDHANDL	Pearson Correlation	-.426(*)	-.371(*)	-.148	-.386(*)	1	.115	.016	.085
	Sig. (2-tailed)	.019	.048	.630	.032	.	.539	.933	.650
	N	30	29	13	31	31	31	31	31
EXISTLAW	Pearson Correlation	-.067	-.083	-.144	.157	.115	1	.176	.117
	Sig. (2-tailed)	.725	.669	.638	.400	.539	.	.344	.530
	N	30	29	13	31	31	31	31	31
LIKEPIC	Pearson Correlation	-.063	.029	.483	.287	.016	.176	1	.434(*)
	Sig. (2-tailed)	.740	.880	.094	.117	.933	.344	.	.015
	N	30	29	13	31	31	31	31	31
LIKEAUDI	Pearson Correlation	-.106	.013	.257	.057	.085	.117	.434(*)	1
	Sig. (2-tailed)	.576	.948	.396	.760	.650	.530	.015	.
	N	30	29	13	31	31	31	31	31

APPENDIX K: BUFFERWARE INTERVIEW GUIDES

K.1 First Deployment Interview Guide

Make sure we have a survey filled out for them. If not, go ahead and have them fill one out.

For all:
What is their understanding of what is going on in that space?

What is their understanding (if any) of buffering/deleting/archiving?

How *private* (or other word as appropriate) did they consider the space before?

Now?

How much does the service being there affect what types of interactions they might have in the space? Do they delete, avoid, etc?

Do they know anyone who has been avoiding the space and/or avoiding talking to Gillian/Gregory about the space? If so, encourage to talk to Giovanni/Erika/Gillian.

People who have used it to archive:
What was the first thing they did... register? save something? delete something? watch something?

What inspired them to first use it?

What kinds of things have they been saving?

Saving for selves? saving for others? both?

Have they gone back and watched things sent by self or by others?

How did the amount of time that the buffer was available affect what/how they archived?

IF they didn't realize the time limit prior to sitting down and archiving, how would it affect things for them in the future?

People who have used the space but have not archived:
How did putting the service in place affect their usage of the space?

Have they considered archiving anything? If so, why not follow through with that?

People who are avoiding the space:
Did they ever use the space before?
If so, what for?

If not, why not?

What specifically is making them avoid the space now?

For people who "just don't like being on camera, having picture taken..." (or some variation), how do they feel about security cameras?

Also, does whether or not they can actively see the camera have anything to do with their comfort level?

Have they considered (or completed) unplugging the mic/covering the camera?

Have they considered using the space and then deleting? Also, want to probe out the deletion of audio when they are not physically in space.

K.2 Second Deployment Interview Guide

Make sure we have a survey filled out for them. If not, go ahead and have them fill one out.

For all:

What is their understanding of what is going on in that space?
In particular, what do they think is going on with the motion detectors?

What is their understanding (if any) of buffering/deleting/archiving?

How *private* (or other word as appropriate) did they consider the space before (probe both before BufferWare entirely if they were here as well as BufferWare version one)?

What effect did the blue line have on this perception?

What effect did the signs have? Did they read them?

Now?

Did they notice the blue line's removal?

Did they notice the changes in the signs? How much of the new signs have they read?

How much does the service being their affect what types of interactions they might have in the space? Do they delete, avoid, etc?

Do they know anyone who has been avoiding the space and/or avoiding talking to Gillian/Gregory about the space? If so, encourage to talk to Erika/Andrea/Gillian.

People who are registered, regardless of whether they have used it:

Are they getting clips from other people? If so, what do they do when they get these clips?

People who have used it to archive:

What was the first thing they did... register? save something? delete something? watch something?

What inspired them to first use it?

What kinds of things have they been saving?

Saving for selves? saving for others? both?

Have they gone back and watched things sent by self or by others?

How did the amount of time that the buffer was available affect what/how they archived?

IF they didn't realize the time limit prior to sitting down and archiving, how would it affect things for them in the future?

People who have used the space but have not archived:

How did putting the service in place/change of service from old BW to new affect their usage of the space?

Have they considered archiving anything? If so, why not follow through with that?

*Of particular intererest are the people who were avoiding before but are not now... what changed it for them?
- change in physical artifacts (line, signs, etc.)
- change in understanding about the service, the deletion, etc.
- other effects...

People who are avoiding the space:
Did they ever use the space before?

If so, what for?

If not, why not?

What specifically is making them avoid the space now?

For people who "just don't like being on camera, having picture taken..." (or some variation), how do they feel about security cameras?

Also, does whether or not they can actively see the camera have anything to do with their comfort level?

Have they considered (or completed) unplugging the mic/covering the camera?
Have they considering moving or otherwise adjusting the motion detectors?

Have they considered using the space and then deleting? Also, want to probe out the deletion for audio when they are not physically in space.

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